977

MODEL 2100
DISPLAY UNIT

Schlumberger

OPERATING AND SERVICE MANUAL

MODEL 2100

DISPLAY UNIT

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SECTION 1

INTRODUCTION

1.1 GENERAL

1.2 The Model 2100 Display Unit consists of a mainframe which is essentially a cathode ray oscilloscope, together with a plug-in module. The two standard plug-in modules are:

Model 2101 Single Channel Logarithmic Amplifier
Model 2104 Dual Channel Logarithmic Amplifier

Other modules for special functions are available to special order. The same mainframe is normally suitable for all plug-in modules.

1.3 Y DEFLECTION CHANNELS

1.4 The Model 2100 has six Y channels; three act as cursor reference lines and the other three can provide measurement information, depending on the plug-in module used. Rear-panel output connectors are provided to give signals proportional to the measurement information and to the cursor positions. These output signals can be used to feed information to a pen recorder or can be incorporated into an automated test program.

1.5 X DEFLECTION

1.6 A direct coupled amplifier provides the X deflection, the input signal being derived from an external source, usually from the sweep oscillator used in the test. The Model M1000 and 1100 Sweep Oscillators have the necessary output signal to drive the X deflection of the 2100 Display Unit.

1.7 DISPLAY

1.8 A 280mm (11 inch) cathode ray tube provides the visual display. Coating of the tube face is long persistence GR phosphor, giving a green bright-up and a green afterglow, suitable for slow sweep speeds.

1.9 MARKERS

1.10 Full screen height and 'pip' ('picket') type markers are available, derived from a marker signal from the sweep oscillator. Marker selection is by means of front-panel pushbuttons.

1.11 If a marker signal is applied to the MARK INPUT connector, marker operation is available, regardless of the plug-in module used.

1.12 MOUNTING

1.13 The Model 2100 Display Unit will have been supplied for either bench or rack mounting. If the instrument is for rack mounting, it is advisable to provide support at the rear.

1.14 POWER SUPPLIES

1.15 The Model 2100, with its associated plug-in module, is designed to operate from an a.c. power supply of 115 or 230V (±10%), 50 to 60Hz, single phase, approximately 100VA.

1.16 Before the instrument is connected to the a.c. supply, MAKE SURE THAT THE REAR-PANEL VOLTAGE SELECTOR PLUGS ARE IN THE CORRECT POSITION FOR THE A.C. POWER SUPPLY AND THAT THE CORRECT MAINS FUSE IS FITTED (0.75A FOR 230V OR 1.5A FOR 115V, SLOW-BLOW).

1.17 The colour coding for the power cable to the instrument is:

BROWN or RED	Line
BLUE or BLACK	Neutral
GREEN/YELLOW or GREEN	Earth

1.18 The earth conductor is connected to the instrument chassis.

1.19 ENVIRONMENT

1.20 The Model 2100 Display Unit, with its associated plug-in module, is designed for operation in an ambient temperature of 0 to 40°C. If it is used in conjunction with a Model M1000 or 1100 Sweep Oscillator, the two instruments may be used side by side or stacked one upon the other. CAUTION: if using a Model M1000 fitted with a Model ML092 or ML093 plug-in unit, the magnetic field about the Sweep Oscillator could cause distortion of the oscilloscope trace on the Display Unit if the two instruments were placed too close together.

1.21 Install or mount the instrument so that there is no obstruction to the fan air intake and outlet on the rear panel.

SECTION 2

SPECIFICATIONS

Table 2.1 Mainframe

MEASUREMENT FUNCTION	Three Y measurement channels are provided; the number of channels used to display information depends on the plug-in module used. Measurements displayed are the levels sensed by external crystal detectors. Three rear-panel output connectors provide information proportional to the position of the Y1, Y2 and Y3 traces, respectively. At the top of the graticule, the output is +0.47V. At the centre, the output is zero and, with the trace on the bottom of the graticule, the output is -0.47V.
CURSORS	Three horizontal cursors are provided, the positions being set by front-panel controls. Three rear-panel output connectors provide information proportional to the position of the three cursor traces. Output voltage is zero when the cursor is on the screen centre. On models up to Serial No. 26, the output at maximum deflection is ±0.47V corresponding to the upper and lower limits of the graticule. On models later than Serial No. 26, the output voltages can be adjusted in a range of approximately zero to ±8V by means of preset potentiometers adjacent to the output connectors. The outputs are normally factory-set to ±0.47V.
MARKERS	Full screen height or 'pip' type markers are available, derived from a marker input signal. The pip type markers ride on the cursor No. 2 trace. Input requirements are: Full Screen: -6V, input impedance 33 kilohm. Pip Type: -3V, input impedance 10 kilohm. Front-panel pushbuttons select OFF, Full Screen or Pip Type.
X DEFLECTION INPUT	An input signal of 8V peak-peak, up to 300Hz, gives full screen deflection. The input can be either positive or negative going. Input impedance is 10 kilohm. No part of the driving waveform may exceed ±20V.
CATHODE RAY TUBE	280mm (11 inch) tube with long persistence GR phosphor coating giving a green bright-up and a green afterglow. Suitable for slow sweep speeds.

TEMPERATURES	
Operating	0 to 40°C.
Storage	-20 to 60°C.

Table 2.2 Models 2101 and 2104 Plug-In Modules

INPUT IMPEDANCE	10 kilohm.
BANDWIDTH	d.c. to 3kHz.
MEASUREMENT RANGE	Useful range depends on the sensitivity of the external crystal detector used. Typical performance range is -70 to -10dBw.
MEASUREMENT ACCURACY	±0.5dB at -10dBW; ±1.1dB at -70dBW.
Y SHIFT	Calibrated -10 to -70dBW.
FREQUENCY RANGE	Power measurements are possible, using suitable crystal detectors, between less than 100kHz and more than 40GHz.
SQUARELAW COMPENSATION	Internal. Front-panel controls can be adjusted to compensate for the transition from square response to linear response, of the crystal detector, with increasing signal level.

SECTION 3

OPERATION

3.1 INTRODUCTION

3.2 The Model 2100 Display Unit mainframe is similar to the mainframe of a conventional cathode ray oscilloscope, differing in some details to make it particularly useful to the microwave engineer.

3.3 Y Deflection Channels. Provision is made for six Y deflection channels. Three of these channels are used as electronic cursors, or reference lines, and their positions on the screen are set by front-panel controls. The other three channels are measurement channels controlled by the plug-in module used.

3.4 X Deflection. A direct coupled X amplifier is provided in the Display Unit. The input signal to the X amplifier must be derived from an external source, usually the sweep oscillator. The Model M1000 and 1100 Sweep Oscillators, companion instruments to the Model 2100, provide the required output to drive the X deflection.

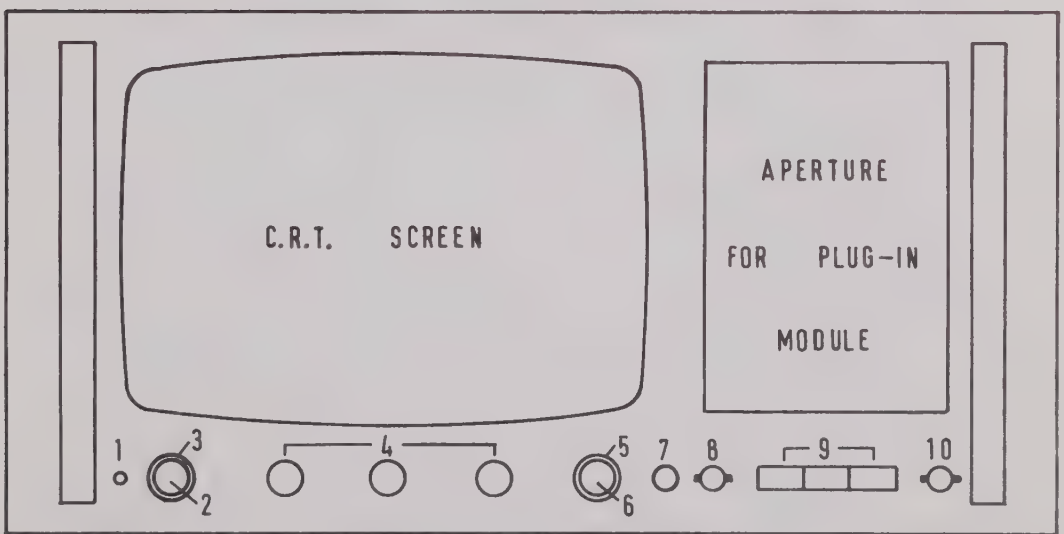
3.5 Markers. Two types of markers are provided, selection being by means of front-panel pushbuttons. The marker signal is derived from an external source, usually the sweep oscillator, and can appear as full screen vertical lines, or pips of about 12mm height on the No. 2 cursor line.

3.6 Y Outputs. Output connectors are provided on the rear panel of the instrument giving output voltages proportional to the measurement channel information (Y1, Y2, Y3). In addition, connectors giving output voltages proportional to the positions of the cursors are fitted.

3.7 CONTROLS AND CONNECTORS

3.8 Mainframe Front Panel (see Figure 3.1)

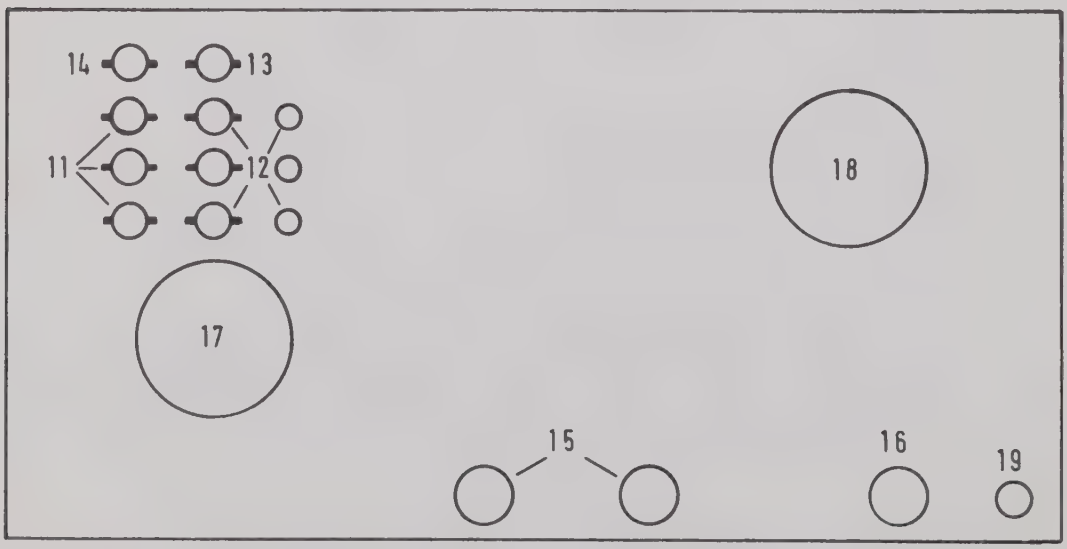
Figure 3.1 Layout of Mainframe Front Panel



1.	Lamp	Lights to indicate that the instrument is switched ON.
2.	ON/OFF	Controls a.c. power to the instrument. Clockwise rotation switches the instrument ON; counterclockwise - OFF.
3.	BRILL	Brilliance control. Clockwise rotation increases the brightness of the display.
4.	CURSORS 1, 2, 3	Three controls for the cursor traces. Clockwise rotation moves the cursor up the screen.
5.	X AMPLIFIER GAIN	Clockwise rotation increases the gain of the X amplifier.
6.	X AMPLIFIER SHIFT	Clockwise rotation moves the display to the right; counterclockwise - to the left.
7.	X AMPLIFIER IN/OUT	Sweep direction pushbutton control. With the pushbutton OUT, a positive going X input signal produces a swept trace from left to right of the screen. With the pushbutton IN, a negative going signal produces a swept trace from left to right of the screen.
8.	X AMPLIFIER INPUT	Connector for external signal to drive the X deflection of the oscilloscope.
9.	MARK	Three pushbuttons to control the marker traces, as follows: OFF - no markers. _/_ - with suitable marker input signal, provides full screen markers. _|||_ - with suitable marker input signal, provides marker pips on the No. 2 cursor trace.
10.	MARK INPUT	Connector for marker input signal. Input requirements are: Full Screen: -6V, input impedance 33 kilohm. Pip Type: -3V, input impedance 10 kilohm.

3.9 Mainframe Rear Panel (see Figure 3.2)

Figure 3.2 Layout of Mainframe Rear Panel



11. Y1, Y2, Y3 — Three Y output connectors providing signals in proportion to the measurement signals. Zero output corresponds to the trace on the horizontal centre line of the screen. ±0.47V correspond to the upper and lower limits of the screen graticule, respectively. The number of Y outputs available depends on the plug-in module used.

12. C1, C2, C3 — Three cursor output connectors providing signals in proportion to the positions of the cursors on the screen. The three preset potentiometers adjust the relevant output voltages. (Not fitted to Models earlier than Serial No. 26).

13. MARKER INPUT — Connector in parallel with front-panel MARK INPUT (10).

14. X INPUT — Connector in parallel with front-panel X AMPLIFIER INPUT (8).

NOTE: connectors (13) and (14) are useful if the Display Unit and Model M1000 or 1100 are rack-mounted.

15. SUPPLY VOLTAGE — Voltage selector plugs. The plugs must be inserted in the positions corresponding to the a.c. supply voltage.

16. Mains Fuse — 0.75A for 230V or 1.5A for 115V, slow-blow fuse.

17. Air Filter — Remove and wash in detergent solution as necessary.

18. Fan — Lubricate bearing periodically by removing the coin-slot screw and applying a few drops of light oil.

19. A.C. Power Cable — Fit with a suitable plug.

3.10 Plug-In Module Front Panel, Models 2101 and 2104 (see Figures 3.3 and 3.4)

Figure 3.3 Model 2101 Front Panel

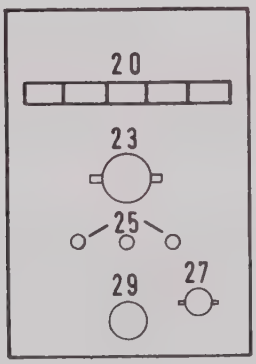
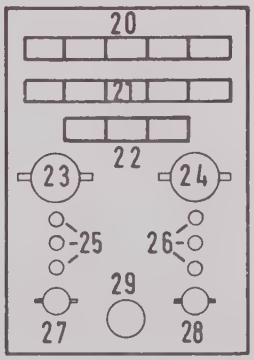


Figure 3.4 Model 2104 Front Panel



20. Window Display — Five pushbuttons marked 3, 6, 12, 30 and 60 (dB), respectively. These pushbuttons determine the amplitude of the displayed signal. When a pushbutton is depressed, the vertical calibration on the screen graticule is the number of dB stated on the pushbutton. For example, if

20. Window Display (continued)	the pushbutton marked 3 is depressed, the graticule vertical centre line corresponds to 3dB, ie, 0.5dB per major division. Model 2101: used on input signal. Model 2104: used on channel A and A/B inputs.
21. Window Display	Model 2104 only. Five pushbuttons as (20) but used on channel B input signal.
22. Mode Switch	Model 2104 only. Three pushbuttons as follows: Pushbutton A depressed, channel A only displayed. Pushbutton A,B depressed, channels A and B displayed on separate traces. Pushbutton A/B depressed, ratio of channel A to channel B displayed. NOTE: channel A input level should always be greater than channel B input.
23. Y Shift	Digitally calibrated potentiometer control to move the trace vertically on the screen. Indicates level directly in -dBW. Model 2101: used on input signal. Model 2104: used on channel A input signal.
24. Y Shift	Model 2104 only. As (23) but used on channel B measurements and A/B ratio measurements as selected by the Mode Switch (22).
25. GAIN, LIN 1, LIN 2	Preset controls to compensate for amplifier and crystal detector characteristics. Model 2101: adjust amplifier. Model 2104: adjust channel A amplifier.
26. GAIN, LIN 1, LIN 2	Model 2104 only. Preset controls to adjust channel B amplifier, otherwise as (25).

NOTE: clockwise rotation of any of these controls (25) and (26), moves the trace towards the top of the screen.

27. INPUT	Input signal connector. Input resistance is 10 kilohm. MODEL 2101: signal input. MODEL 2104: channel A signal input.
28. INPUT	Model 2104 only. Input connector for channel B. Input resistance is 10 kilohm.
29. Lock	'CAMLOC' type fastener to secure the module in the mainframe. Clockwise to fasten; counter-clockwise to release.

3.11 SWITCHING ON

3.12 Before a connection is made to the instrument, MAKE SURE THAT THE REAR-PANEL VOLTAGE SELECTOR PLUGS ARE IN THE CORRECT POSITION FOR THE A.C. POWER SUPPLY AND THAT THE CORRECT MAINS FUSE IS FITTED (0.75A FOR 230V OR 1.5A FOR 115V SLOW-BLOW). Proceed as follows:

1. Refer to Paragraphs 3.8, 3.9 and 3.10 for the location of controls and connectors.
2. Ensure that the plug-in module is securely mounted in the mainframe.
3. Connect the instrument to a suitable power supply.
4. Turn the ON/OFF switch clockwise to the ON position. ON condition of the instrument is indicated when the red signal lamp lights.
5. Connect a suitable X deflection signal to the X AMPLIFIER INPUT. This signal can be taken from a Model M1000 or 1100 Sweep Oscillator, or other source.
6. If no trace appears on the screen within about 45 seconds, set the three CURSORS controls to approximately mid-range, turn the BRILL control fully clockwise and adjust the X AMPLIFIER GAIN and SHIFT

controls so that the traces fill the horizontal width of the screen and are centred about the graticule vertical centre line. Re-adjust the BRILL control for suitable brightness.

3.13 MARKERS

3.14 If a suitable marker signal is applied to either the front-panel MARK INPUT or to the rear-panel MARKER INPUT connector, markers will be available on the display, regardless of the plug-in module used.

3.15 Two types of markers are available, selected by the front-panel MARK pushbuttons, as follows:

a. _/_ With this pushbutton depressed, the markers are 'full screen', ie, vertical lines filling the height of the screen. This type of marker requires a triggering signal of amplitude at least -6V into 33 kilohm.

b. _|||_ With this pushbutton depressed, the markers available are 'pip' or 'picket' type (vertical lines approximately 12mm high) riding on the No. 2 cursor trace. This type of marker requires a triggering signal of amplitude at least -3V into 10 kilohm.

3.16 Both types of markers are triggered by a voltage level and, therefore, do not depend on the speed of the input pulses. If the marker input signal were a slow moving ramp, of sufficient amplitude, the markers would be triggered at a particular voltage level, the triggering being unaffected by the waveshape of the input signal.

3.17 PLUG-IN MODULES

3.18 The two standard plug-in modules available for use with the Model 2100 mainframe are:

Model 2101: Single Channel Amplifier
Model 2104: Dual Channel Amplifier

3.19 General. The logarithmic amplifier is designed to accept the output voltage from a crystal detector fed with an RF signal. This output voltage is given a logarithmic characteristic so that the calibration of the graticule vertical line can be linear for direct measurement in dB. The window display pushbuttons control the amplitude of the signal displayed on the screen and calibrate the display. In the case of the Model 2104 plug-in module, each logarithmic amplifier is separately controlled by the Y shift and window display controls.

3.20 Installation. The plug-in module should be inserted in the aperture in the mainframe front panel and carefully pushed home to mate the mainframe and module connectors. When the module is in place, the 'CAMLOC' knob should be turned clockwise to secure the module.

3.21 CRYSTAL CALIBRATION PROCEDURES

3.22 The calibration procedure is necessary to compensate for the characteristics of the amplifier and crystal detector. Adjustment to the amplifier is required to correct for drift, which is noticeable at very small voltages, ie, very low RF power levels. Preset LIN 1 is used for this adjustment.

3.23 At low signal levels, the crystal detector output follows a square law and, at higher levels, the response is linear. By making the necessary adjustment to the amplifier, compensation for this transition is effected so that the Y shift control, with digital read-out, is calibrated. Preset control LIN 2 is used for this adjustment.

3.24 When LIN 1 and LIN 2 controls have been properly adjusted, the output voltage from the amplifier varies linearly as the RF power into the crystal detector varies logarithmically.

3.25 By applying a known power level to the crystal detector, the Y shift control can be set to this power and the GAIN control adjusted so that

the trace on the screen corresponds to the known power level.

3.26 To summarise:

LIN 1 is effective at low power levels and corrects for amplifier drift.

LIN 2 is effective at high power levels and compensates for crystal characteristics.

GAIN fixes one point on the linearised amplifier output to calibrate the Y shift control.

The methods of adjusting these three controls are described in Paragraphs 3.27 and 3.28.

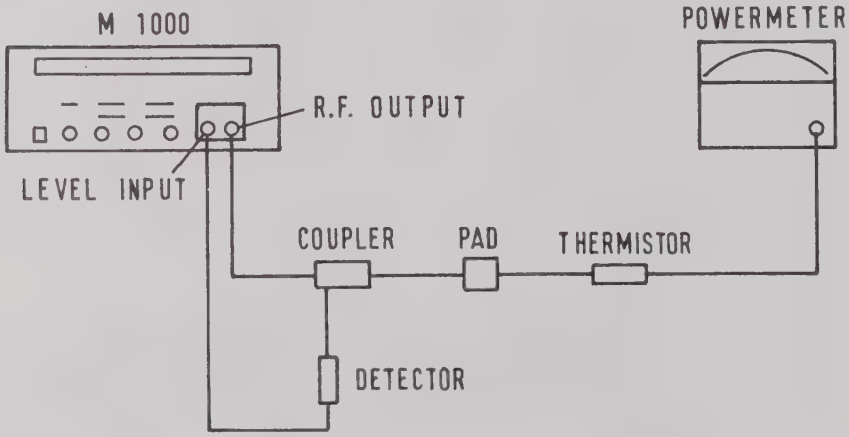
3.27 Crystal Calibration using Variable Attenuator. Proceed as follows:

Equipment Required: Model M1000 or Model 1100 Sweep Oscillator, or equivalent.
Model 2100 mainframe with either Model 2101 or 2104 plug-in module.
Crystal detector (eg, HP 423A or Alfred type 1001).
60dB variable attenuator suitable for the frequency of the RF input to the crystal detector. This would normally be a rotary vane attenuator.
Power meter with 10dB pad and thermistor. (Only necessary for absolute measurements; not necessary for ratio measurements made with the Model 2104 module).
Coupler and detector for the levelling loop (if needed).
Connecting cables.

Procedure:

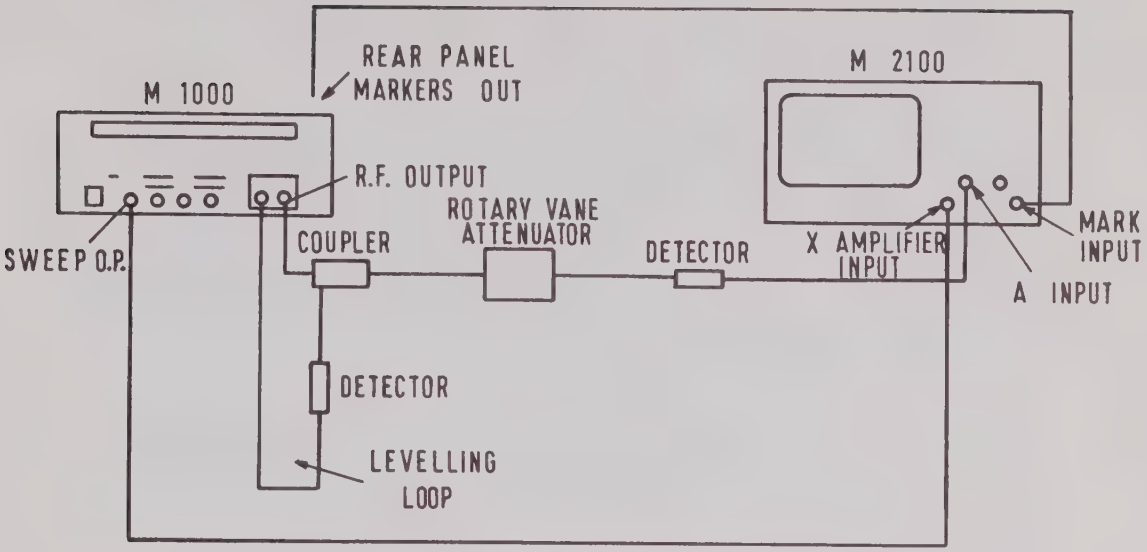
1. Connect the equipment as shown in Figure 3.5.

Figure 3.5 Measuring Sweep Oscillator Output



2. Set the M1000 or 1100 controls for a narrowband sweep.
3. Set the M1000 or 1100 for a levelled RF output of 100mW, or other convenient power level. 100mW = -10dBW; 10mW = -20dBW.
4. Reconnect the equipment as shown in Figure 3.6

Figure 3.6 Crystal Calibration



5. Assuming the RF output from the Sweep Oscillator to be 100mW, set the attenuator to 40dB. Select the 60dB window display pushbutton on the plug-in module and adjust the Y shift control to bring the trace near to the screen centre. (This step is included to facilitate 'finding' of the trace).
6. Select the 12dB window display pushbutton, adjust the Y shift control to bring the trace to the screen centre and note the setting of the Y shift digital read-out.
7. Change the attenuator setting to 60dB and set the Y shift control to read 20.0 higher than the reading noted in step 6.
8. Adjust the LIN 1 preset control to position the trace on the screen centre.
9. Check that the adjustment of the LIN 1 control has not affected the reading with 40dB set on the attenuator (step 6). If the reading has altered, repeat steps 6, 7 and 8.
10. Note the final reading on the Y shift control with 40dB set on the attenuator. Reduce the setting of the Y shift control by 40.0 and set the attenuator to 0dB.
11. Adjust the LIN 2 preset control to position the trace on the screen centre.
12. Check that the adjustment of the LIN 2 control has not affected the reading of the Y shift control with 40dB set on the attenuator (step 10). If the reading has altered, repeat steps 6 through 11.
13. The crystal detector has now been calibrated for relative power measurements. The calibration procedure this far could have been accomplished with an unknown power level, ie, step 3 could have been omitted. Calibration would, however, have been suitable for relative measurements only.
14. The linearity of the detector + amplifier characteristics can be checked by taking readings of the Y shift read-out with the attenuator set to 0, 5, 10 and so on in 5dB steps to 60dB. With a typical crystal, the linearity should be within $\pm$0.2dB.

15. To calibrate for absolute power measurements, set the attenuator to 0dB, ie, the power to the crystal detector is as set in step 3. If this is 100mW (-10dBW), set 10.0 on the Y shift control. Adjust the GAIN preset control to position the trace on the screen centre.
16. The crystal has now been calibrated for absolute, as well as relative, power measurements.

3.28 Crystal Calibration using Attenuator Pads. Refer to Paragraph 3.27. The only difference between the calibrating procedures using fixed and variable attenuators is found in the linearity test, step 14. The choice of fixed pads will permit linearity tests at any increment desired but, generally, it has been found that, if the required attenuation of 60dB is made up of two 10dB and two 20dB pads, satisfactory calibration can be obtained. The calibration procedure is, basically, the same as Paragraph 3.27, substituting the pads in their various combinations for the variable attenuator.

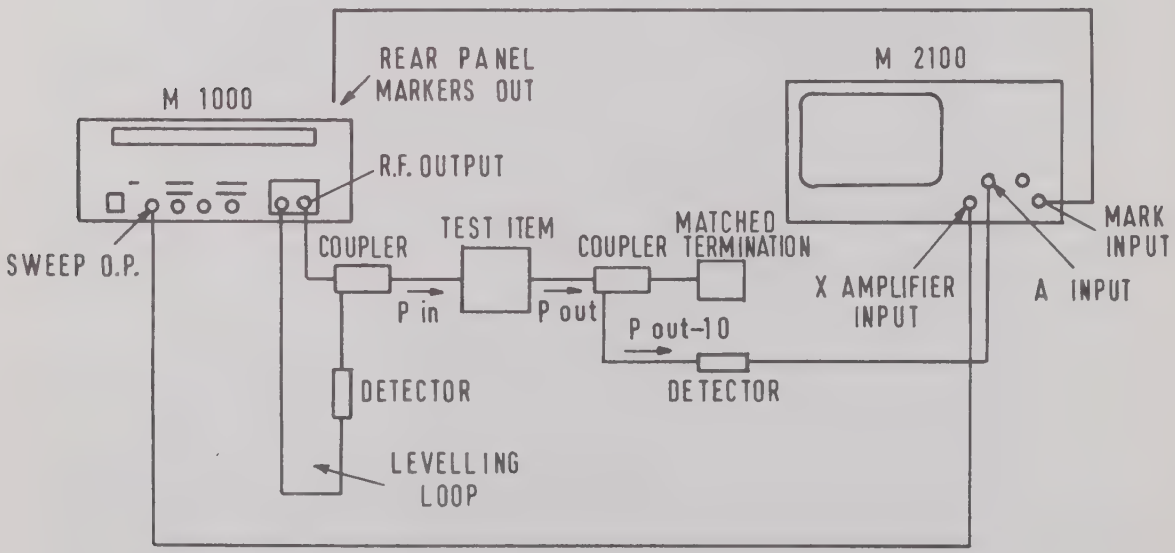
3.29 MEASUREMENTS

3.30 The following three paragraphs describe typical measurements that can be made with the Model M1000 or 1100 Sweep Oscillator and the Model 2100 Display Unit measuring system. In all cases, the Sweep Oscillator should be set up for levelled operation as described in the relevant Operating and Service Manual.

3.31 Single Channel Power Measurement. The procedure for the measurement of Power, Gain, Insertion Loss, Bandwidth and Frequency Response using a single channel Model 2101 module, or one channel only of a Model 2104 module, is as follows:

1. Calibrate the crystal detector (Paragraphs 3.27 and 3.28).
2. Set the Sweep Oscillator for the desired output.
3. Connect the equipment as shown in Figure 3.7

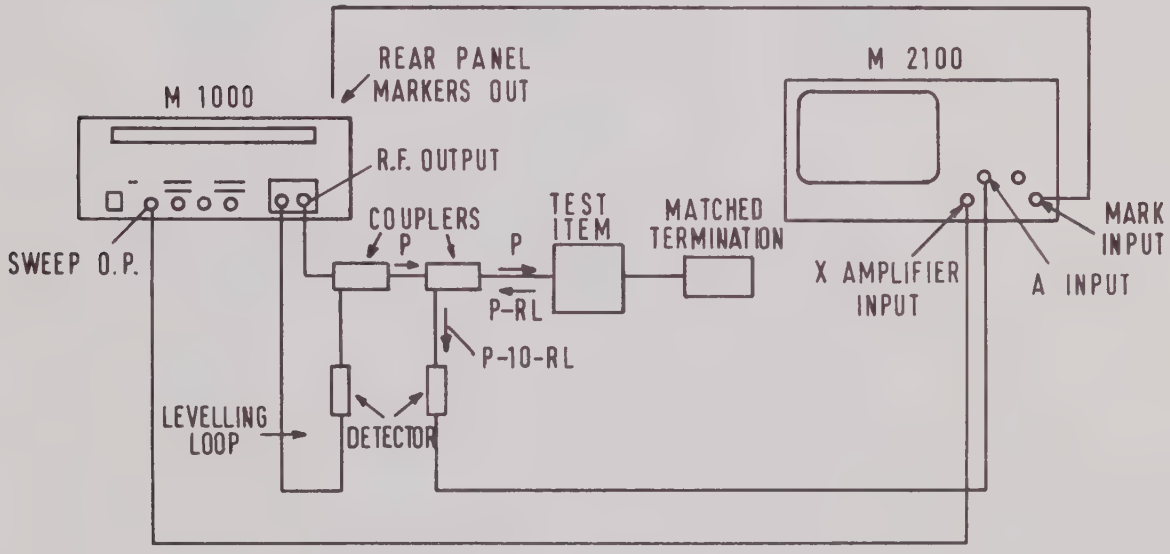
Figure 3.7 Single Channel Power Measurement



4. Adjust the Model 2101 or 2104 plug-in module window display push-buttons and Y shift control to obtain a suitable trace from which a power measurement can be made.
5. The difference between the output power from the Sweep Oscillator less 10dB (insertion loss in the coupler), and the power measured in step 4, gives the gain or insertion loss of the test item.
6. If it is desired to investigate any particular part of the trace, set the Sweep Oscillator M1 and M2 frequency markers at the ends of the part under review and select M1 - M2 on the SWEEP pushbuttons. The frequency response of the test item can, therefore, be observed over the entire trace or, more accurately, over a part of particular interest.

3.32 Single Channel Return Loss Measurement. The procedure for the measurement of Return Loss using a single channel Model 2101 module, or one channel only of a Model 2104 module, is as follows:
1. Calibrate the crystal detector (Paragraphs 3.27 and 3.28).
2. Set the Sweep Oscillator for the desired output.
3. Connect the equipment as shown in Figure 3.8.

Figure 3.8 Single Channel Return Loss Measurement



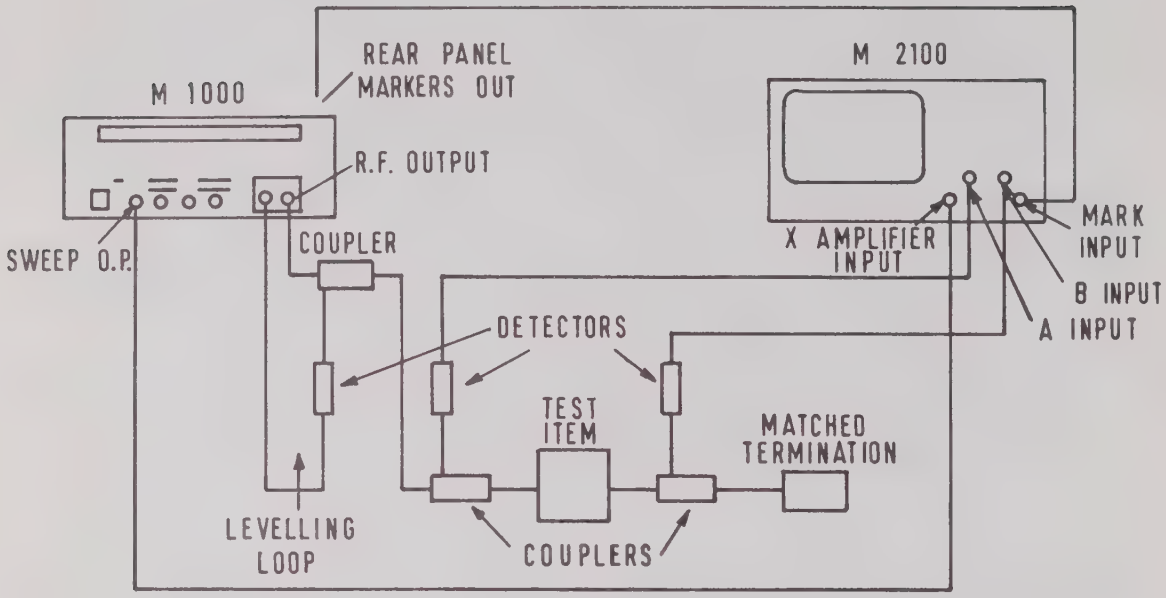
4. Adjust the Model 2101 or 2104 plug-in module window display push-buttons and Y shift control to obtain a suitable trace from which a power measurement can be made.
5. Calculate the Return Loss of the test item as follows:
   P = power to coupler = incident power to test item (dBW)
   P - RL = reflected power from test item (dBW) where RL = Return Loss
   P - 10 - RL = power to crystal detector (dBW)
   Pm = measured power (dBW)
   RL = P - Pm - 10 (dB)

3.33 Dual Channel Power and Return Loss Measurements. The procedure for the measurement of Return Loss on channel A and Power, Gain, Insertion Loss, Bandwidth and Frequency Response on channel B, using a Model 2104

plug-in module, is as follows:

1. Connect the equipment as shown in Figure 3.9

Figure 3.9 Dual Channel Measurements



2. Measure Return Loss on the Y1 trace (channel A) of the Display Unit as described in Paragraph 3.32.
3. Measure Power, Gain, Insertion Loss, Bandwidth and Frequency Response on the Y2 trace (channel B) of the Display Unit as described in Paragraph 3.31.

SECTION 4

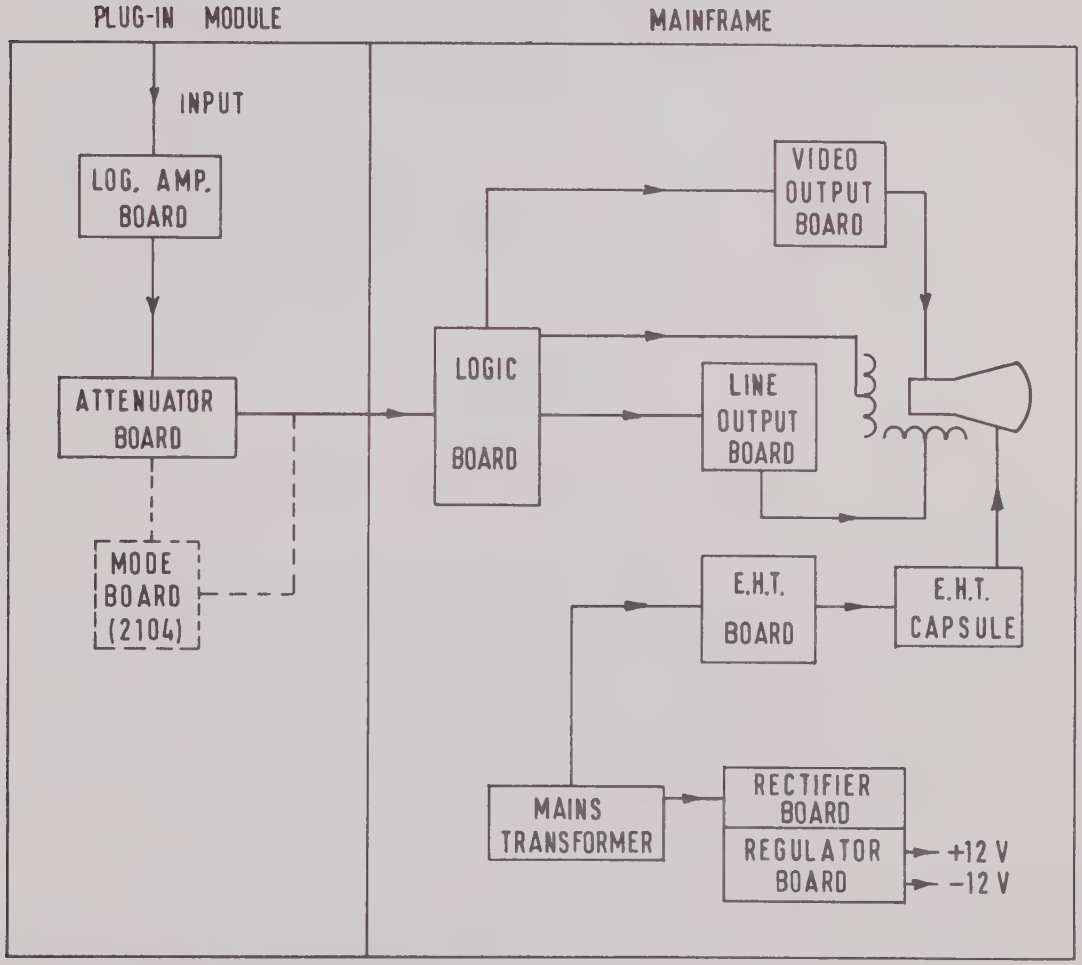
PRINCIPLES OF OPERATION

4.1 INTRODUCTION

4.2 Figure 4.1 is a simplified block diagram of the Model 2100 Display Unit together with its plug-in module. The purpose of this Section of the Manual is to give a basic description of the various 'blocks' in Figure 4.1. For the sake of clarity, the low voltage supply connections have been omitted.

4.3 The Figures in this Section represent, diagrammatically, the functions of the circuits involved. The actual circuits differ in detail from these diagrams.

Figure 4.1 Simplified Block Diagram



4.4 MAINFRAME

4.5 The mainframe of the Display Unit consists of what may be termed the 'oscilloscope' section. Internally generated within the mainframe are the EHT supply, the vertical line scan at approximately 30kHz and the cursors. Also developed within the mainframe, triggered by external signals, are the measurement traces, from the plug-in module, and the frequency markers. A sweep signal, applied to the X AMPLIFIER INPUT, allows the traces to be swept across the screen.

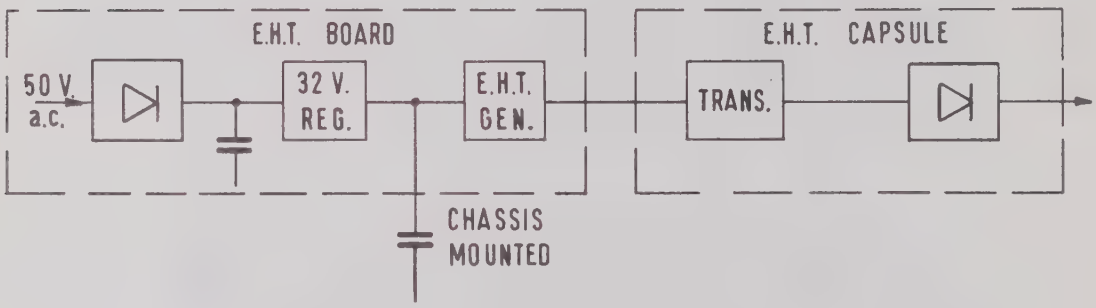
4.6 The oscilloscope section of the Display Unit consists of a monitor type cathode ray tube which is excited with a 'subdued' raster, that is to say, when the instrument is operating, the tube is continuously scanned with vertical lines of insufficient intensity to light up the tube face. A Y input, whether from the plug-in module or from the cursor control potentiometers, will provide a vertical signal causing a bright-up spot on each of the raster lines at the relevant position on the screen. A signal applied to the X amplifier, of suitable form, will result in a sweep to produce the horizontal deflection causing these bright-up spots to appear as horizontal traces.

4.7 RECTIFIER AND REGULATOR

4.8 This section, fed from the mains transformer, develops a +16V unregulated supply for the Line Board and ±12V regulated supplies. Other outputs are +100V unregulated and +360V regulated supplies for the anode of the cathode ray tube. Conventional circuitry is used in this section.

4.9 EXTRA HIGH TENSION (EHT) SUPPLY (Figure 4.2)

Figure 4.2 EHT Supply Section

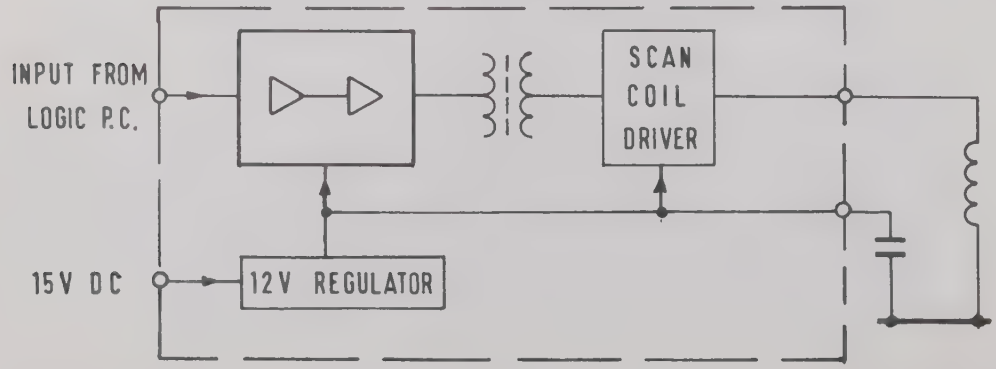


4.10 A 50V a.c. supply from the mains transformer is bridge rectified and smoothed, and the output is fed to the EHT generator section which is, in effect, a blocking oscillator. EHT over-voltage protection is provided by a circuit which senses the d.c. voltage to the blocking oscillator and trips the d.c. supply if the voltage rises above a safe limit.

4.11 The output from the blocking oscillator is converted by the EHT transformer to a series of high voltage pulses which are rectified by two diodes in series, and smoothing is provided by the capacitance of the cathode ray tube.

4.12 LINE OUTPUT BOARD (Figure 4.3)

Figure 4.3 Line Output Board

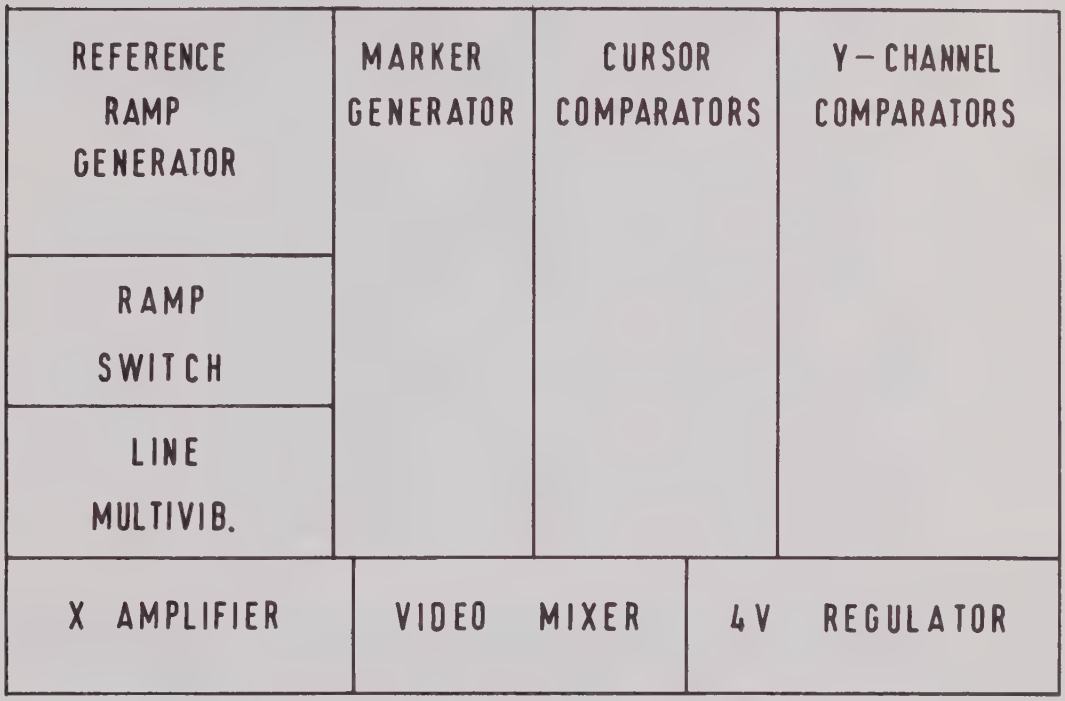


4.13 The Line Output Board is supplied with a squarewave from the Line Multivibrator, which is mounted on the Logic Board. The squarewave is converted to a high voltage pulse train which produces, in a conventional manner, the linear sawtooth current in the vertical deflection coils on the cathode ray tube. This produces the vertical lines, scanning from bottom to top of the screen, forming the raster.

4.14 LOGIC BOARD

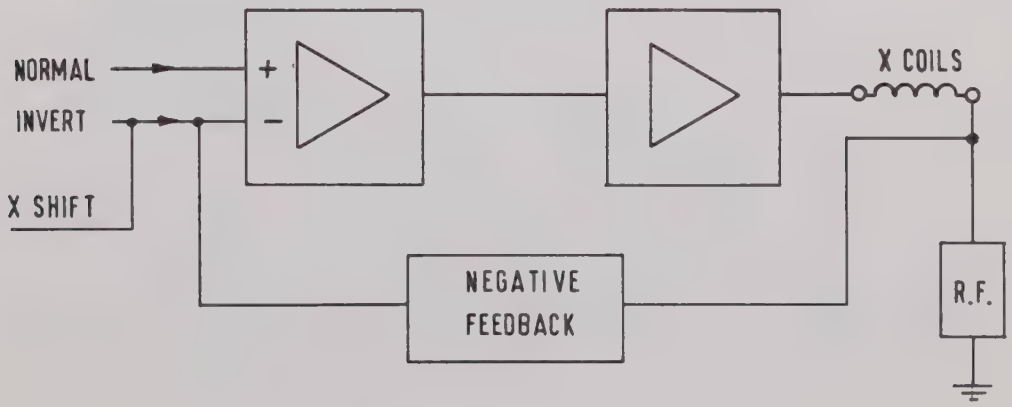
4.15 The Logic Board, PC107, performs many functions in the Display Unit. Figure 4.4 shows the various areas of this board and, in the following paragraphs, these areas will be described.

Figure 4.4 Logic Board



4.16 X AMPLIFIER (Figure 4.5)

Figure 4.5 X AMPLIFIER



4.17 The X amplifier section of the Display Unit consists of an operational amplifier followed by a complementary symmetry amplifier with current feedback. The sweep signal, applied to the front- or rear-panel connector, is normally fed to the non-inverting input of the operational amplifier. A front-panel pushbutton switch, when operated, connects the sweep signal to the inverting input of the operational amplifier to reverse the direction of the sweep. This facility is provided so that the instrument can be made to sweep right to left or left to right with either a positive going or negative going sweep signal applied to the X input connector.

4.18 In addition, a signal from the X shift control is applied to the inverting input of the operational amplifier to enable the trace to be horizontally positioned on the screen.

4.19 The output from the X amplifier produces a current in the horizontal deflection coils of the cathode ray tube which varies as the applied input sweep signal voltage. Thus, a sawtooth sweep signal will produce a linear sweep and a sinusoidal sweep signal will produce a sinusoidal sweep.

4.20 LINE MULTIVIBRATOR AND RAMP SWITCH

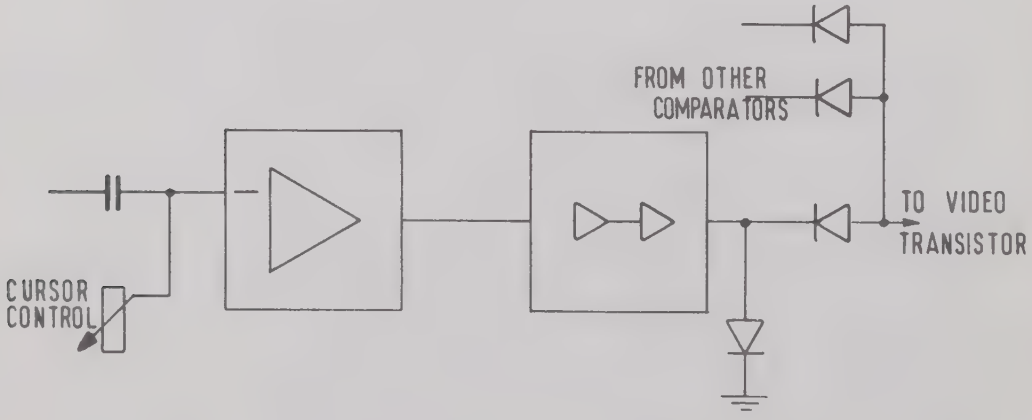
4.21 The Line Multivibrator section generates a squarewave output to supply the Line Output Board, the Ramp Switch and the Marker Generator. Two sections of a hex. inverter are used as the multivibrator and a third section is used as a buffer for the Line output. The other three sections are used for the Ramp Switch. One section of the Ramp Switch is fed directly from the Line Multivibrator and converts the symmetrical squarewave from the multivibrator to a positive going rectangular waveform with a mark:space ratio of approximately 3:1. This waveform is applied to the input of the remaining two sections of the hex. inverter. The inverted waveform is fed by one section to the Video Mixer to give vertical retrace blanking. The other inverted output provides the switching waveform for the Reference Ramp Generator.

4.22 REFERENCE RAMP GENERATOR

4.23 The Reference Ramp Generator develops a positive going linear sawtooth waveform of approximately 4V which is applied to the six comparators (three for the measurement traces and three for the cursors). The duration of the sawtooth is the same as the line scan.

4.24 CURSOR COMPARATORS (Figure 4.6)

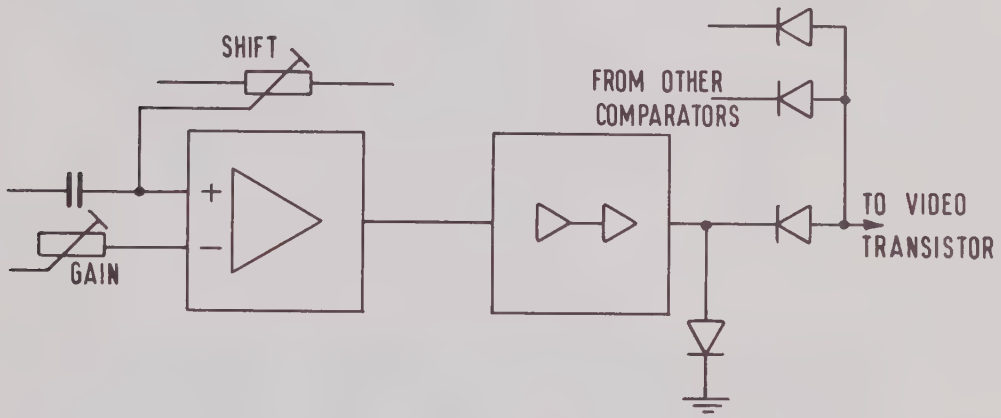
Figure 4.6 Cursor Comparators



4.25 Each Cursor Comparator consists of an operational amplifier integrated circuit. The output from the Reference Ramp Generator is a.c. coupled to the inverting input of the operational amplifier and is added to a sample of the voltage from the wiper of the cursor control potentiometer. Clockwise rotation of the cursor control through its full range produces a voltage swing from positive through zero to an equal negative value. When the combination of the voltage derived from the cursor control potentiometer and the ramp voltage passes through zero in a positive going direction, the operational amplifier will produce a large negative going voltage step (from approximately +5V to +0.5V) at its output. This voltage step is passed through two sections of a hex. inverter to give a fast edge. The output from the hex. inverter is differentiated and added to the outputs of the other comparators, via diodes, and fed to the video transistor.

4.26 Y COMPARATORS (Figure 4.7)

Figure 4.7 Y Comparators



4.27 The Y Comparators are similar to the Cursor Comparators, with the addition of shift and gain controls.

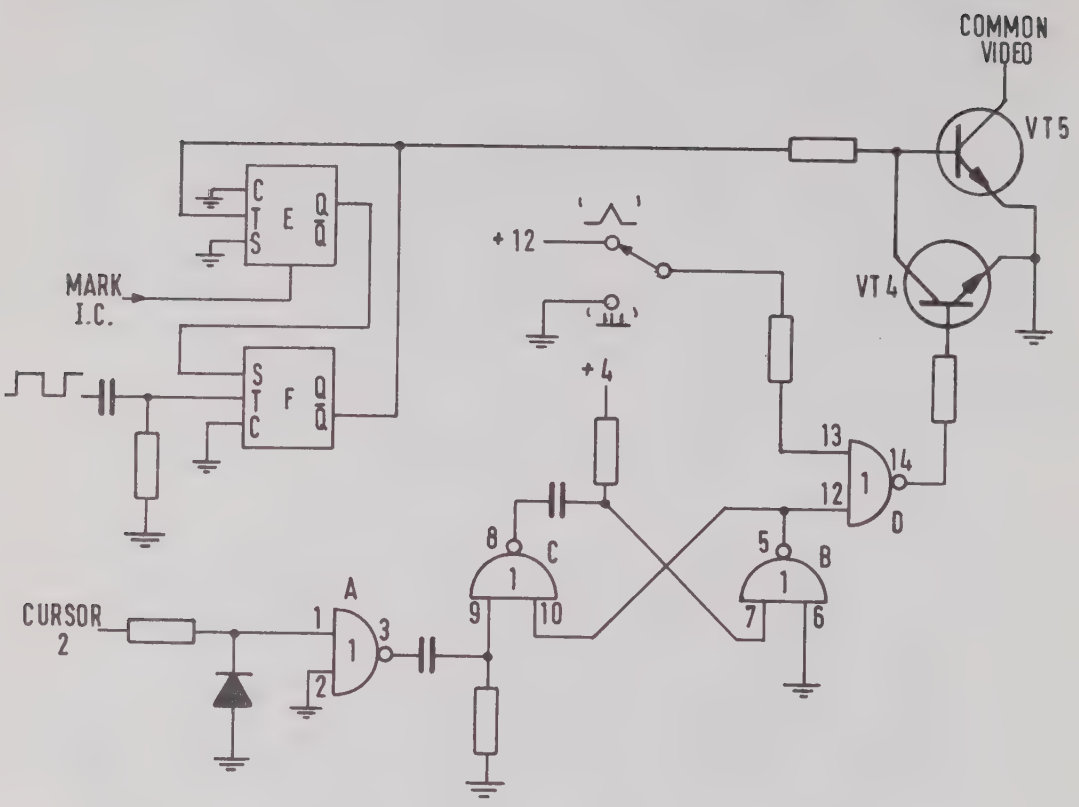
4.28 MARKER GENERATOR (Figure 4.8)

4.29 The initial processing of the marker input signal for both full screen (_/_) and picket (_|||_) markers is performed in IC12 (dual J-K integrated circuit). The input from the Line Multivibrator is a square waveform, synchronised with the line scan, which is differentiated and fed to the T input of gate F. With no marker input to gate E, Q(gate E) = 1. On gate F, therefore, S = 1, C = 0 and Q is held at 0 so that VT5 has no effect on the common video output.

4.30 When the marker pulse is applied to gate E (approximately 2V positive spike), Q(gate E) becomes 0. S and C on gate F are then both 0 and at the next negative edge of the input squarewave from the Line Multivibrator, $\bar{Q}$ becomes 1, turning VT5 ON to produce bright-up of the relevant vertical scan line, when the full screen (_/_) marker pushbutton is selected.

4.31 The following negative going edge of the squarewave will cause the $\bar{Q}$ output of gate F to go to 0, turning VT5 OFF and removing the marker line. The $\bar{Q}$ output of gate F is also applied to the T input of gate E, resetting the gate and hence rendering gate F inoperative until another marker pulse is received.

Figure 4.8 Marker Generator



4.32 With the above operation of full screen markers, the output of gate D of IC11 is a permanent 0 holding VT4 OFF. When the picket (⊥⊥⊥) pushbutton is selected, the input to pin 13 of gate D changes from 1 to 0 so that the output of the gate depends on the input to pin 12.

4.33 Gates B and C form a monostable which, in the stable state, puts a 0 on pin 12 of gate D so that the output 1 turns VT4 ON.

4.34 Assume that a line scan has just commenced, that a marker pulse has started and that cursor 2 is on the graticule centre line. Because VT4 is conducting, VT5 is held OFF and no bright-up appears. When the line scan reaches the position of cursor 2, the cursor comparator produces a negative going step which is applied to input 1 of gate A. This produces a trigger pulse to the monostable, the time duration of which depends on the characteristics of the monostable, turning VT4 OFF. This allows VT5 to turn ON, producing a bright-up riding on cursor 2. The monostable is designed so that the height of the picket markers is approximately 12mm.

4.35 PLUG-IN MODULE

4.36 The Model 2101 plug-in module consists, essentially, of a logarithmic amplifier, an attenuator board and a Y shift control. In addition, linearity and gain controls are provided for crystal calibration (see Paragraphs 3.21 through 3.28). The Model 2104 module has two inputs, two logarithmic amplifiers, two attenuator boards, two Y shift controls, two sets of linearity and gain controls and, in addition, a Mode switch. The Mode switch is used to select: channel A, channels A and B or the ratio channel A:B.

4.37 The logarithmic amplifier accepts the d.c. signal from an external crystal detector and converts it to a logarithmic slope. The logarithmic signal then passes through the attenuator board which is used to set the sensitivity and calibrate the vertical graticule line. The Y shift control, which has a digital read-out, enables power measurements to be made directly in dBW and ratio measurements in dB.

4.38 The Model 2113 plug-in module is basically the same as the Model 2104 with the addition of a fixed sensitivity (approximately 500mV for full scale deflection) linear amplifier. A positive going signal to this linear amplifier moves the trace up the screen.

SECTION 5

MAINTENANCE

5.1 GENERAL

5.2 This Section of the Manual is divided into three parts:
1. Performance Tests, Paragraphs 5.8 through 5.18.
2. Alignment Procedure, Paragraphs 5.19 through 5.22.
3. Fault-Finding Procedure, Paragraphs 5.23 through 5.25.

5.3 For routine performance checks or, if it is suspected that the instrument is not operating within specification, perform the tests described in the first part.

5.4 If the instrument is found to be operating outside specification but otherwise satisfactorily, employ the alignment procedure described in the second part.

5.5 If the instrument is not operating, or cannot be brought within specification by following the alignment procedure, refer to the third part.

5.6 DISMANTLING THE MODEL 2100

C A U T I O N

THE INSTRUMENT OPERATES FROM HIGH AND EXTRA HIGH VOLTAGES WITHIN THE COVERS. ONLY QUALIFIED PERSONNEL, FAMILIAR WITH SAFETY RULES AND PRACTICES, SHOULD SERVICE THE EQUIPMENT. ALWAYS DISCONNECT THE INSTRUMENT FROM THE A.C. POWER SUPPLY BEFORE REMOVING THE COVERS.

5.7 The dismantling procedure is as follows:
1. Disconnect the a.c. power cable from the mains supply.
2. Remove the plug-in module by turning the 'CAMLOC' type fastener counterclockwise and sliding the module forwards.
3. Remove the instrument from its case or mounting rack.
4. Remove the top and bottom covers.

PART 1

PERFORMANCE TESTS

5.8 REFERENCE SETTINGS

5.9 Before performing any of the following tests, set all controls to the following Reference Settings. The instructions will indicate any changes from these settings:

Mainframe Front Panel	
ON/OFF	ON
BRILL	For suitable brightness
CURSORS 1, 2, 3	Approximately mid-range
X AMPLIFIER GAIN and SHIFT	For suitable horizontal trace
X AMPLIFIER IN/OUT	OUT
MARK	OUT
Mainframe Rear Panel	
SUPPLY VOLTAGE	To suit available power supply
Plug-In Module	
Window Display	All pushbuttons OUT
Mode Switch (Model 2104 only)	Pushbutton A depressed
Y Shift	40.0

5.10 MODEL 2100 MAINFRAME

5.11 X AMPLIFIER INPUT

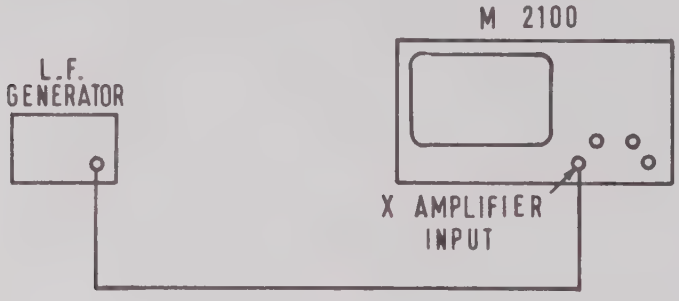
Specification: 8V peak-peak input signal, up to 300Hz, gives full screen deflection.

Equipment Required: Low frequency generator, up to 300Hz.
Connecting cables.

Procedure:

1. Set controls to Reference Settings (Paragraph 5.9) and connect the equipment as shown in Figure 5.1.

Figure 5.1 X Deflection Test



2. Set the low frequency generator to lowest frequency output at 8V peak-peak.
3. Adjust the Model 2100 CURSORS and X AMPLIFIER GAIN and SHIFT controls for a trace to fill the horizontal width of the screen.
4. Increase the frequency output from the LF generator to 300Hz.
5. Check that the trace can still be made to fill the width of the screen by adjustment of the X AMPLIFIER controls.

5.12 CURSORS

Specification: Three horizontal cursors each of which can travel the full vertical height of the screen by means of the front-panel CURSORS 1, 2 or 3 control. On Models later than Serial No. 26, voltage signals are available at rear-panel connectors which are in proportion to the cursor positions. The signals are adjustable in a range of approximately zero to $\pm$8V by means of preset potentiometers adjacent to the connectors.

Equipment Required: Low frequency generator, up to 300Hz.
Digital voltmeter.
Connecting cables.

Procedure:

1. Set controls to Reference Settings (Paragraph 5.9) and connect the equipment as shown in Figure 5.1 (Paragraph 5.11).
2. Adjust the Model 2100 CURSORS and X AMPLIFIER GAIN and SHIFT controls for a trace to fill the horizontal width of the screen.
3. Check that each cursor trace can be made to travel the full vertical height of the screen by means of the front-panel CURSORS controls.
4. Connect the voltmeter to the rear-panel C1 cursor connector.
5. Position cursor No. 1 at the top of the screen and check that the output voltage can be made to vary from near zero to approximately +8V by means of the preset potentiometer adjacent to the connector.
6. Position the cursor at the bottom of the screen and check that the output voltage can be made to vary between near zero and -8V.
7. Check that the output is linear by measuring the voltage with the cursor at several positions on the screen.
8. Repeat steps 5, 6 and 7 for the other two cursors.

5.13 MARKERS

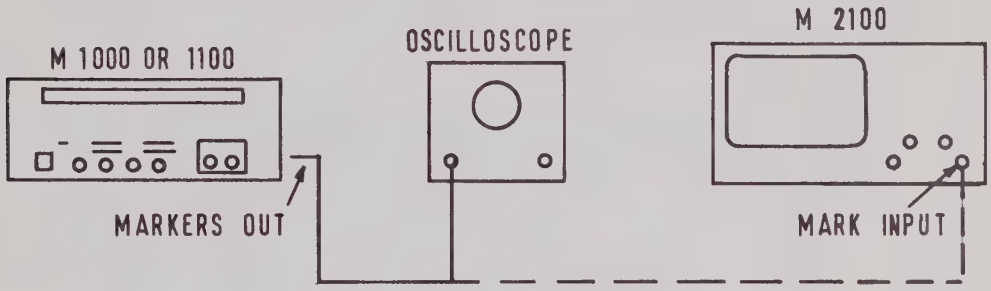
Specification: Full screen height markers from a -6V input signal.
Pip type markers on cursor No. 2 from a -3V input signal.

Equipment Required: Model M1000 or 1100 Sweep Oscillator.
General purpose oscilloscope.
Connecting cables.

Procedure:

1. Set controls to Reference Settings (Paragraph 5.9) and connect the equipment as shown in Figure 5.2

Figure 5.2 Marker Test



2. Set the Sweep Oscillator for F1 - F2 fast sweep with M1 and M2 on scale between the F1 and F2 frequencies.
3. Depress the sweep oscillator MARK pushbutton and adjust the AMP control for a -6V output.
4. Transfer the connection from the oscilloscope to the Model 2100 MARK INPUT connector and depress the _/_ MARK pushbutton.
5. Check that full screen markers are present on the screen.
6. Transfer the connection from the Model 2100 MARK INPUT connector to the oscilloscope.
7. Adjust the Sweep Oscillator AMP control for a -3V output.
8. Transfer the connection from the oscilloscope to the Model 2100 MARK INPUT connector and depress the _|||_ MARK pushbutton.
9. Check that 'pip' type markers, approximately 12mm high, are present on the No. 2 cursor.

5.14 Y DEFLECTION

Specification: Three measurement channels.

Equipment Required: Model M1000 or 1100 Sweep Oscillator.
Connecting cables.

Procedure:

1. Connect the Sweep Oscillator SWEEP O.P. to the Model 2100 X AMPLIFIER INPUT and select FAST on the Oscillator controls.
2. The three measurement traces should be superimposed to form a single line at the screen centre. NOTE: the plug-in module must be removed for this test.

5.15 PLUG-IN MODULES, MODELS 2101 AND 2104

5.16 BANDWIDTH

Specification: d.c. to 3kHz

Equipment Required: Low frequency generator, up to 3kHz.
Model 2100 mainframe.
Connecting cables.

Procedure:

1. Set the low frequency generator for a sinewave output at 3kHz, zero amplitude.
2. Select the 60dB window display pushbutton on the plug-in module.
3. Connect the low frequency generator to the Model 2101 INPUT or to the Model 2104 channel A INPUT.
4. Increase the output power level of the generator and adjust the Y shift control on the plug-in module for a trace filling the height of the screen.
5. Reduce the frequency output from the generator to minimum.
6. The amplitude of the trace on the screen should not vary by more than $\pm$1dB.
7. If a Model 2104 plug-in module is under test, repeat for the channel B INPUT.

5.17 GENERAL

5.18 Select a suitable crystal detector and perform the crystal calibration procedure described in Paragraphs 3.21 through 3.28. The successful completion of this procedure will prove the correct operation of the unit.

PART 2

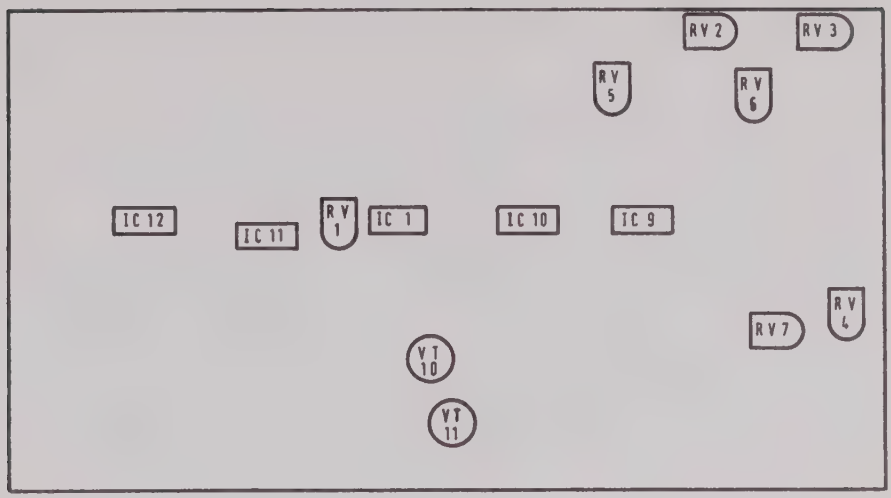
ALIGNMENT PROCEDURE

5.19 MAINFRAME

5.20 To align the mainframe of the Model 2100, remove the plug-in module, apply a sweep signal (below 300Hz) to the X AMPLIFIER INPUT and proceed as follows:

1. Connect the instrument to a suitable a.c. power supply and switch ON.
2. After a delay of about 45 seconds, traces should become visible. If not, adjust the BRILL and X AMPLIFIER GAIN and SHIFT controls until the traces appear, symmetrical about the graticule vertical line.
3. If the traces are not horizontal, adjust the scan coils as follows:
   i. Slacken the brass screw on the clamp at the neck of the cathode ray tube.
   ii. Turn the ring to which the coils are attached, by means of the insulated lug, until the traces are horizontal.
   iii. Tighten the brass screw.
   iv. Adjust the magnets in front of the brass clamp for traces of uniform intensity.
4. If there is a vertical line at the edge of the trace, adjust RV1 on the video board, attached to the base of the tube, until the line just disappears.
5. Turn the CURSORS controls to remove the cursor traces from the screen.
6. Adjust RV5, RV6 and RV7 (see Figure 5.3) on the logic board to obtain three separate traces.
7. Readjust RV5, RV6 and RV7 so that the traces are superimposed on the graticule horizontal centre line.
8. Apply a +0.33V d.c. signal, from a d.c. standard voltage source, to the rear-panel Y1 connector.
9. Adjust RV2 on the logic board so that the trace is deflected by two major divisions of the graticule towards the top of the screen.
10. Reverse the polarity of the 0.33V signal and check that the trace is deflected the same distance towards the bottom of the screen.

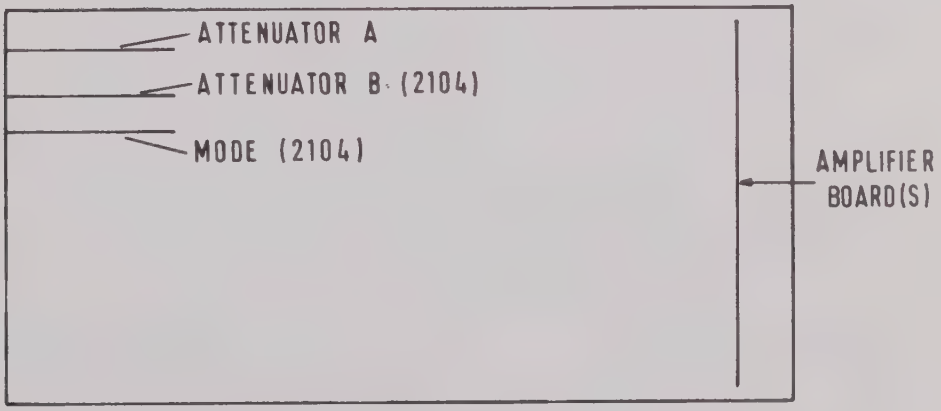
Figure 5.3 Logic Board



11. Repeat steps 8, 9 and 10 for the Y2 and Y3 traces, using the Y2 and Y3 connectors and adjusting RV3 and RV4, respectively.
12. Turn the CURSORS No. 1 control to bring a cursor on the screen. Adjust RV1 on the logic board so that, when the control is turned clockwise, the trace vanishes at the top of the tube-face midway between the edge of the graticule and the edge of the screen. Check that the cursor vanishes at a corresponding point at the bottom of the screen when the control is turned counterclockwise.

5.21 PLUG-IN MODULE (see Figure 5.4)

Figure 5.4 Side View of Plug-In Module



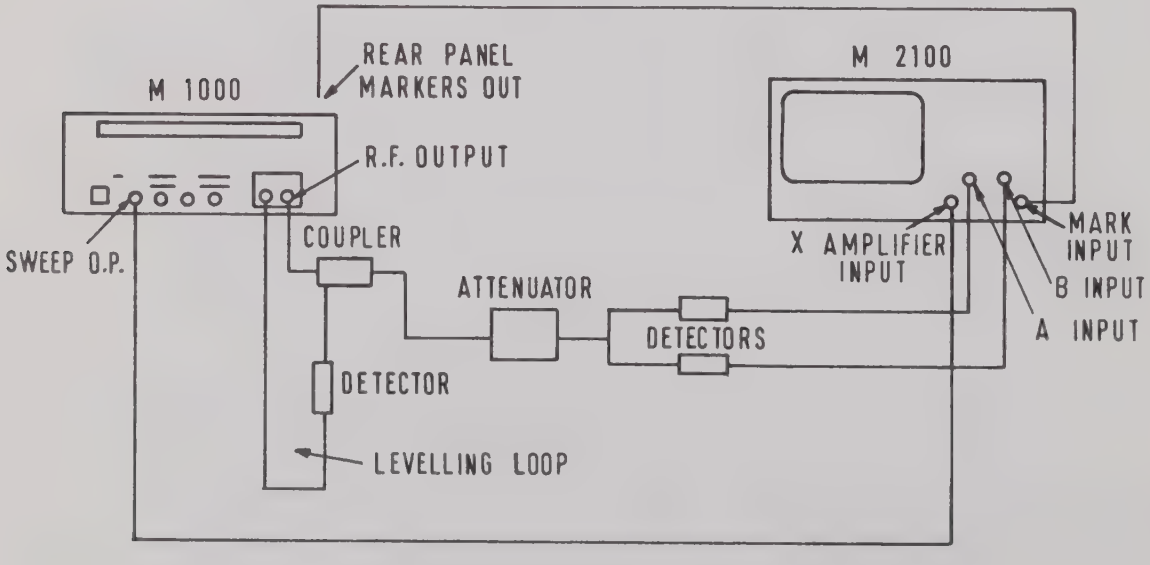
5.22 To align a Model 2101 or 2104 plug-in module, proceed as follows:
1. Remove the module from the mainframe and connect to the mainframe using an extension connector.
2. Set the front-panel LIN 2 preset fully counterclockwise.
3. Connect the earth terminals of the amplifier and attenuator boards to the chassis of the module. (In the case of a Model 2104 module, this applies, initially, to the channel A boards.)

4. Connect an oscilloscope to the wiper of the LIN 1 potentiometer and adjust LIN 1 for OV.
5. Terminate the INPUT (channel A, if Model 2104) with a 50 ohm load.
6. Connect the oscilloscope to the test point between IC2 and R14 on the amplifier board.
7. Turn RV1 on the amplifier board fully clockwise.
8. Turn RV1 counterclockwise until the oscilloscope trace falls negative. Turn clockwise until the trace has just stabilised and then turn a little further until the trace is seen to rise slightly.
9. If Model 2104, repeat for the channel B amplifier.
10. Return the module to the mainframe.
11. Select a suitable crystal detector, (or two detectors for Model 2104), and calibrate as described in Paragraphs 3.21 through 3.28.
12. With an input of 100mW (-10dBW), set 10.0 on the Y shift control (channel A if Model 2104). Adjust the GAIN control to position the trace on the screen centre.
13. Select 12dB on the window display pushbuttons and 30dB on the attenuator. Adjust the Y shift control to centre the trace.
14. Select 30db on the window display pushbuttons and range the attenuator between 20 and 40dB. Adjust the potentiometer nearer the CRT on the attenuator board so that the shift of the trace about the centre of the screen is symmetrical $\pm$0.5dB.
15. Set 30dB on the attenuator and 40.0 on the Y shift control. Adjust the Gain control to position the trace on the screen centre.
16. Set 10dB on the attenuator and 20.0 on the Y shift control. Adjust the other potentiometer on the attenuator board to position the trace on the screen centre.
17. Repeat step 14 and, if necessary, steps 15 and 16.
18. Check the linearity of the detector + amplifier response as Paragraph 3.27, step 14. If the response is not linear within $\pm$0.2dB, repeat steps 12 through 18.
19. If the plug-in module is a Model 2104, repeat steps 11 through 18 for the channel B INPUT.

MODEL 2104 ONLY

20. Connect the equipment as shown in Figure 5.5.

Figure 5.5 Alignment of Ratio Mode - Model 2104



21. Select A,B on the mode pushbuttons. Set both Y shift controls so that the two traces are on the screen centre. Lock the channel A Y shift control.
22. Set the channel B Y shift control to the same setting as the channel A Y shift control. Adjust the channel B GAIN control to return the B trace to the screen centre.
23. Select A/B on the mode pushbuttons and 60dB on the A/B window display. Turn the channel B Y shift control towards zero (counterclockwise) to find the trace.
24. Set the potentiometer nearer the CRT on the mode board so that the trace remains stationary within ±0.25dB when the attenuator is ranged from 0 to 60. Repeat with 30, then 12 and, finally, 3dB window display pushbutton selected.
25. Set the channel B Y shift control to the same setting as the channel A Y shift control and adjust the other potentiometer on the mode board to centre the trace on the screen.

PART 3

FAULT-FINDING PROCEDURE

5.23 FAULT-FINDING

5.24 If the Model 2100 Display Unit is not functioning correctly, proceed as follows:

1. Check the a.c. power supply, mains fuse and LINE indicating lamp.
2. Remove the plug-in module.
3. Connect a sweep signal to the X AMPLIFIER INPUT (approximately 10V peak-peak at 100Hz).
4. Switch the instrument ON and check that three cursor traces are present, controlled by the front-panel CURSORS, X AMPLIFIER GAIN and SHIFT controls.
5. Check that a measurement trace is present approximately on the screen horizontal centre line.
6. Apply a +0.33V d.c. signal to the rear-panel Y1, Y2 and Y3 connectors in turn. In each case, a Y measurement trace should separate from the centre line and move two major divisions of the graticule towards the top of the screen.
7. A -0.33V d.c. signal applied to the same connectors should move the Y traces two major divisions towards the bottom of the screen.
8. If the above tests can be successfully accomplished, the fault lies in the plug-in module, unless the problem is in the MARKERS operation, in which case refer to Test G1 in Table 5.1.

5.25 If the tests in Paragraph 5.24 indicate that the fault lies in the mainframe, follow the procedure in Table 5.1, starting at Test A1. If the fault is in the plug-in module, start at Test H1. Table 5.1 consists of a series of tests which enables the service engineer to pin-point a fault to a circuit board or, in some cases, to a single component. The Table begins with Test A1 which asks a question. If the answer is YES, the engineer should proceed to the next question beneath. If the answer is NO, the test indicated in the right-hand column should be performed. At the end of a run of YES operations, the fault will be localised to a circuit board or to a component.

C A U T I O N

THE TESTS IN TABLE 5.1 CAN ONLY BE MADE WITH THE COVERS REMOVED. THIS EXPOSES HIGH AND EXTRA HIGH VOLTAGE TERMINALS AND SERVICE OF THE INSTRUMENT SHOULD ONLY BE ATTEMPTED BY ENGINEERS FAMILIAR WITH SAFETY RULES AND PRACTICES.

Table 5.1 Fault-Finding Procedure

Test	Test Description	If NO refer to Test
A1	With the plug-in module removed, a sweep signal connected and the instrument switched ON, are there any cursor traces?	A7
A2	Is there any measurement trace?	A6
A3	Can all three cursor traces be made to travel the full height of the screen by means of the front-panel CURSORS control?	A7
A4	Can the three Y measurement traces be made to travel the full height of the screen by applying a ±0.5V d.c. signal to the rear-panel Y1, Y2 and Y3 connectors?	A27
A5	The Y channels are functioning correctly. NOTE: if the traces appear as unswept spots, check the X amplifier as Test B1. Also check that the ±12V supplies are not affected by turning the X SHIFT control through its full range.	
A6	Are there three measurement traces on the screen?	A27
A7	Are one or two cursor traces present on the screen?	A12
A8	Refer to PC107 and check the coupling capacitor and buffer resistor for connecting the ramp signal to the relevant IC5, IC6 or IC7 (C15, R18 for cursor No. 1; C16, R21 for cursor No. 2; C17, R24 for cursor No. 3). Are they correct?	A17
A9	Monitor pin 2 (output) of relevant IC with an oscilloscope. Can a stepped output, variable by means of the front-panel CURSORS control, be obtained?	A18
A10	Substitute IC9 for IC10. Has the missing cursor trace reappeared?	A32
A11	Replace IC10.	
A12	Are all the cursor traces missing?	A7
A13	Refer to PC107. Is the output from the Reference Ramp Generator a ramp of approximately 4V?	A19
A14	Is the output from the Line Multivibrator (LINE O/P) an approximate squarewave of 1.5V?	A22
A15	Is the output from the Ramp Switch (input to R8) an approximate squarewave of 1.5V with a 1:3 mark:space ratio?	A24
A16	Proceed to Test C1.	
A17	Replace faulty component.	
A18	Check VT5 and, if correct, replace faulty IC.	
A19	Is +4V supply to IC1 present?	A26
A20	Are R1, R2, C8, C9, C11, D1 and D2 correct?	A17
A21	Replace faulty IC1.	
A22	Are RV1 and R8 correct?	A17
A23	Replace faulty IC1.	
A24	Are R5 and C7 correct?	A17
A25	Replace faulty IC1.	

Table 5.1 Fault-Finding Procedure (cont'd)

Test	Test Description	If NO refer to Test
A26	Investigate and rectify.	
A27	Are one or two measurement traces present on the screen?	A13
A28	Check coupling capacitor and buffer resistor for connecting the ramp signal to the relevant IC2, IC3 or IC4 (C12, R11 for Y1; C13, R14 for Y2; C14, R17 for Y3). Are they correct?	A17
A29	Monitor pin 2 (output) of relevant IC with an oscilloscope. Is an approximate squarewave, 4V amplitude, present?	A18
A30	Substitute IC10 for IC9. Has the missing measurement trace reappeared?	A32
A31	Replace IC9.	
A32	Investigate components associated with IC; also VT5.	
B1	Following from Test A5, do the traces appear as unswept spots?	A5
B2	Monitor the voltage at the X SHIFT input to PC107 (the wiper of the X SHIFT potentiometer). Can it be ranged between approximately ±12V d.c. by means of the front-panel X SHIFT control?	B9
B3	Monitor the NORM input to PC107. With the front-panel X AMPLIFIER IN/OUT pushbutton in the OUT position, can the voltage at this pin be ranged between approximately zero and the output from the external generator which is providing the sweep signal, by means of the X SHIFT control?	B9
B4	Use an oscilloscope to monitor the output from IC13 (pin 6). The output signal carries quite a lot of noise and, in order to observe the fundamental, it is advisable to reduce the brilliance control of the oscilloscope. Adjust the X SHIFT control to position the spot traces on the graticule vertical centre line. Adjust the X GAIN control for a measurement of approximately 3V peak-peak. Can this be achieved?	B10
B5	Measure the voltage at the base of VT8. Is it 10V d.c.?	B11
B6	Measure the voltage at the collector of VT8. Is it approximately 17V peak-peak?	B12
B7	Measure the voltage at the junction of D45 and D46. Is it approximately 17V peak-peak?	B13
B8	Investigate horizontal scan coils.	
B9	Investigate front-panel components and wiring.	
B10	Replace IC13.	
B11	Check R71 and ZD1.	
B12	Replace VT8.	

Table 5.1 Fault-Finding Procedure (cont'd)

Test	Test Description	If NO refer to Test
B13	Investigate VT9, VT10, VT11 and components. NOTE: if only half the screen can be swept, the fault will be associated with either VT10 and components or with VT9, VT11 and components.	
C1	Is the output from the Video Mixer on PC107 (VID O/P) a squarewave approximately 0.3V amplitude?	C3
C2	Proceed to Test D1.	
C3	Is R8 (Ramp Switch) correct?	C5
C4	Investigate VT6, VT7 and components.	
C5	Replace faulty resistor.	
D1	Is the line output signal from the Line Multivibrator (Test A14) present at the base of VT1 on PC180?	D10
D2	Is +12V d.c. rough supply present at pin 13?	D10
D3	Is regulated 12V d.c. supply present across pins 9 (+ve) and 10? (NOTE: there is some noise normally present).	D11
D4	Is the voltage at the collector of VT1 approximately 10V squarewave?	D12
D5	Is the voltage at the collector of VT2 approximately 25V squarewave with approximately 5V spike on the leading edge?	D13
D6	Is the voltage between C4 and R7 approximately 25V peak-peak and an approximate squarewave about earth?	D14
D7	Is the voltage at the anode (pin 6) of D1 mounted on the heat sink assembly (HSA4) 80 to 110V negative going pulses?	D15
D8	Check scan coils for continuity. Are they correct?	D10
D9	Proceed to Test E1.	
D10	Investigate and rectify.	
D11	Investigate REG1, VT1 mounted on heat sink HSA4, and components.	
D12	Investigate VT1 and components.	
D13	Investigate VT2 and components.	
D14	Investigate T1 and components.	
D15	Investigate D1, VT1 mounted on heat sink HSA4, C6 through C11 and the chassis-mounted capacitor.	
E1	Is the input signal from PC107 present at pin 4 of PC110?	E7
E2	Is +100V present at pin 9 of PC110?	E7
E3	Is -12V present at pin 5 of PC110?	E7
E4	Is a voltage between 350 and 500V d.c. present at pin 6 of PC110?	E7

Table 5.1 Fault-Finding Procedure (cont'd)

Test	Test Description	If NO refer to Test
E5	Measure the voltage at pin 7 of the tube base (junction of C4, C5 and R6). Is it approximately +70V with negative going pulses, approximately 40V, representing the cursor and measurement traces?	E8
E6	Proceed to Test F1.	
E7	Investigate and rectify.	
E8	Investigate VT1, VT2 and components.	
F1	Is there a humming noise from the EHT capsule?	F3
F2	The EHT supply is almost certainly correct. If it is desired to check the EHT output, some means of measuring approximately 12kV must be used.	
F3	Check the input to the EHT board PC198 (PC113 in earlier models). Is it 50V a.c. rms (141 peak-peak)?	F7
F4	Is the voltage across the chassis-mounted capacitor 32V d.c.?	F7
F5	Measure the voltage between pins 9 and 10. Is this a series of pulses approximately 40V amplitude?	F8
F6	The EHT board is correct. (See NOTE, below.)	
F7	Investigate and rectify.	
F8	Measure the voltage at pin 1. Is it approximately 35V?	F11
F9	Measure the voltage at pin 2. Is it approximately 70V?	F12
F10	Check VT6 and components.	
F11	Investigate VT5 and components.	
F12	Investigate VT4 and components.	
NOTE:	If the EHT board is PC 198, momentarily short circuit pins 1 and 3. This should trip the EHT which is indicated by the humming noise in the EHT capsule diminishing to zero and the traces gradually fading. If the trip does not function, investigate VT1, VT2 and components. To reset, switch the instrument OFF for a few seconds and then switch ON.	
G1	Are both picket ('pip') and full screen markers missing?	G7
G2	Are ±12V supplies present at IC8 on PC107?	G10
G3	Are +4V supplies present at IC11 and IC12?	G10
G4	Apply a sweep signal and a marker signal. The marker signal should be about 7V amplitude at the same frequency as the sweep signal. Measure the output from IC8 at pin 6 of the IC. Is this an approximate squarewave, 20V peak-peak symmetrical about earth with a mark:space ratio varying with the amplitude of the marker input signal?	G11

Table 5.1 Fault-Finding Procedure (cont'd)

Test	Test Description	If NO refer to Test
G5	Monitor the input to IC12 at the junction of R45 and D27. Is the input a small d.c. offset with fast positive going pulses superimposed?	G12
G6	Check VT4 for short circuit, VT5 for open circuit, and IC12 and components.	
G7	Are picket markers present but full screen markers missing?	G13
G8	Check MARK front-panel switch and associated wiring. Are they correct?	G10
G9	Investigate IC11 and components.	
G10	Investigate and rectify.	
G11	Investigate IC8 and components.	
G12	Investigate R45 and D27.	
G13	Are full screen markers present but picket markers missing?	G1
G14	Is VT4 short circuit?	G16
G15	Replace faulty component.	
G16	Investigate IC11 and components.	
NOTE:	The following series of Tests apply to the Models 2101 and 2104 plug-in modules. Where the module is Model 2104 dual channel, the Tests, where relevant, must be made on both the channel A and channel B sections. IMPORTANT: when making these Tests, the input to the channel being tested must be terminated with a 50 ohm load.	
H1	Insert the plug-in module into the mainframe making sure that the plug and socket connectors are properly mated. Release all front-panel pushbuttons and wait about one minute for the traces to stabilise. Depress the 60dB window display pushbutton(s) and the A,B pushbutton if Model 2104. Can the measurement trace(s) be positioned on the screen by the Y shift and LIN 1 controls?	H4
H2	Perform the crystal calibration procedure as described in Section 3, Paragraphs 3.21 through 3.28. Can this be successfully accomplished?	H4
H3	The plug-module is correct.	
H4	Remove the plug-in module and connect to the mainframe with an extension cable. Earth the amplifier and attenuator boards (PC172 and PC115). Measure all ±12V, ±10V and ±6V supplies. Are they correct?	H12
H5	If module is Model 2104, is only one trace present?	H13

Table 5.1 Fault-Finding Procedure (cont'd)

Test	Test Description	If NO refer to Test
H6	It would appear that the other channel is faulty. If the module is a single channel unit, the following procedure applies also. Check that the range of the Y shift control is +12 to -8V d.c. Is this correct?	H12
H7	Set the front-panel preset LIN 2 fully counterclockwise and LIN 1 for OV at the wiper. Turn preset RV1 on the amplifier board PC172 fully clockwise. Monitor the voltage at the output of IC4 (junction with R28). It should be approximately -2.5V. Turn RV1 counterclockwise until the trace is seen to fall negative. Can this be accomplished?	H14
H8	Turn RV1 clockwise until the voltage is just stable at -2.5V. Measure the voltage at the emitter of VT1 on PC172. Does this vary from +12 to -0.5V when the LIN 2 preset is turned from fully counterclockwise to fully clockwise?	H20
H9	Measure the voltage at the collector of VT2 on PC172. Does this vary from approximately -2 to +12V when the LIN 2 preset is turned from fully counterclockwise to fully clockwise?	H21
H10	Are diodes D4, 5, 6 and 7, and resistors R19 and 27 correct?	H22
H11	Proceed to Test J1.	
H12	Investigate and rectify.	
H13	If neither measurement trace is present, investigate the plug connector, panel wiring and mode board PC116.	
H14	Monitor the voltage at the output of IC3 (junction with R15). It should be approximately -250mV. Turn RV1 counterclockwise until the trace is seen to fall negative. Can this be accomplished?	H16
H15	Investigate IC4 and components.	
H16	Monitor the voltage at the output of IC2 (junction with R14). Turn RV1 until the voltage is stable at approximately +850mV. Turn RV1 counterclockwise until the trace is seen to fall negative. Can this be accomplished?	H18
H17	Turn RV1 clockwise until the voltage is just stable at the value measured in Test H16. Investigate IC3 and components.	
H18	Open the link between R2 and IC3. Use a two-channel oscilloscope to monitor the ±d.c. inputs to IC2. The voltage at each input should be approximately 1V and a total swing of approximately 100mV about this level should be possible by turning RV1 through its full range. The two traces on the oscilloscope should cross to prove that the amplifier can be balanced. Can this be achieved?	H23

Table 5.1 Fault-Finding Procedure (cont'd)

Test	Test Description	If NO refer to Test
H19	Investigate IC1 and components	
H20	Investigate VT1 and components	
H21	Investigate VT2 and components	
H22	Replace faulty component.	
H23	Investigate components between preset LIN 1 and ± inputs to IC2.	
J1	If the Tests in the 'H' section of this Table are all successful and there is a fault in the plug-in module, the next area to check is the attenuator board PC115. Check the ±12V d.c. supplies to IC1 and IC2. Are they correct?	J7
J2	Is the input at pin 7 of PC115 the same as the output from PC172 (Test H7)?	J7
J3	Does the input to pin 9 of PC115 vary between +12 and -8V for the full range of the Y shift control?	J7
J4	Select the 12dB window display pushbutton and measure the output at pin 2. Does this vary between approximately +4 and -5V for the full range of the Y shift control?	J5 & J8
J5	Repeat for the other window display pushbuttons. Are the results approximately as follows:	J10
J6	The attenuator board is functioning correctly.	
J7	Investigate and rectify.	
J8	Select the 12dB window display pushbutton and measure the output at pin 8. Does this vary between approximately -5V and +6V for the full range of the Y Shift control?	J11
J9	Investigate IC2 and components.	
J10	Investigate attenuator switch(es) and resistor(s).	
J11	Investigate IC1 and components.	

Window Display dB	Voltage with Y Shift Control: clockwise	counterclockwise
3	+8V	-8.2V
6	+7.5V	-8V
12	+4V	-5V
30	+2V	-2V
60	+1V	-1V

SECTION 6

CIRCUIT AND COMPONENT LAYOUT DIAGRAMS

LIST OF CONTENTS

Figure 6.1 2100 Mainframe Wiring Schematic Diagram
6.2 2104 Module Wiring Schematic Diagram
6.3 2104 Module Switching Mode Diagram

Mainframe PC Assemblies

6.4 PC108 Layout (Rectifier)
6.5 PC108 Circuit (Rectifier)
6.6 PC107 Layout (Logic)
6.7 PC107 Circuit (Logic)
6.8 PC110 Layout (Video)
6.9 PC110 Circuit (Video)
6.10 PC179 Layout (Regulator)
6.11 PC179 Circuit (Regulator)
6.12 PC180 Layout (Line)
613 PC180 Circuit (Line)
6.14 PC198 Layout (EHT Driver)
6.15 PC198 Circuit (EHT Driver)

Module PC Assemblies

6.16 PC115 Layout (Attenuator)
6.17 PC115 Circuit (Attenuator)
6.18 PC172 Layout (Logarithmic Amplifier)
6.19 PC172 Circuit (Logarithmic Amplifier)
6.20 PC116 Layout (Mode Switch)
6.21 PC116 Circuit (Mode Switch)

Model 2113 Module with Linear Channel C Amplifier

6.22 PCNV1071 Layout (2113 Linear Channel)
6.23 PCNV1071 Circuit (2113 Linear Channel)

Earlier Version (3-Digit Serial Numbers)

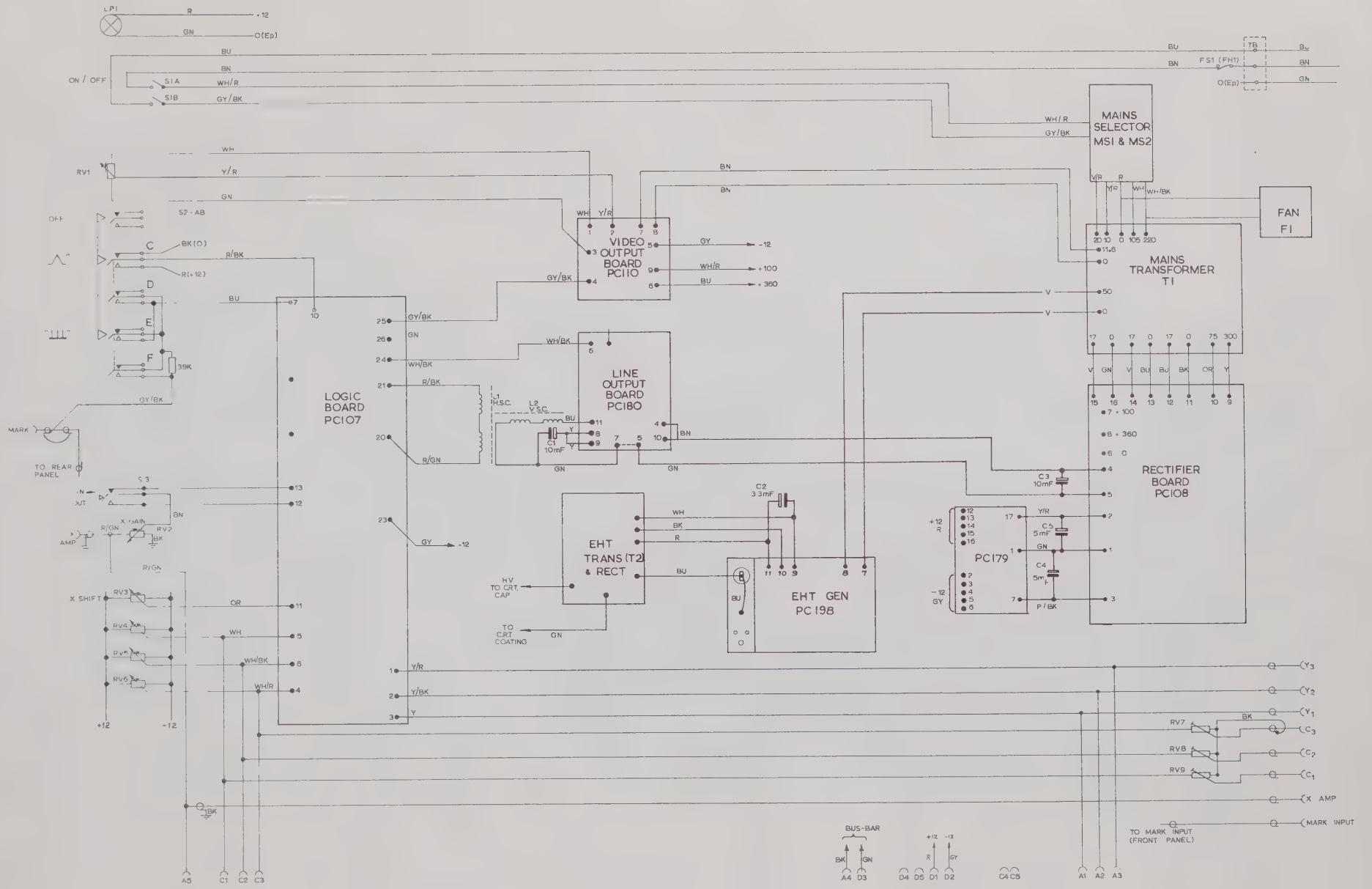

LP1
R
+12
GN
O(Ep)
ON / OFF
S1A
S1B
WH/R
GY/BK
BU
BN
TB
FS1 (FH1)
MAINS SELECTOR MS1 & MS2
FAN F1
MAINS TRANSFORMER T1
VIDEO OUTPUT BOARD PC110
LINE OUTPUT BOARD PC180
LOGIC BOARD PC107
RECTIFIER BOARD PC108
EHT TRANS (T2) & RECT
EHT GEN PC198
PC179
RV1
S2 - AB
OFF
BK (O)
R/BK
R (+12)
39K
MARK
TO REAR PANEL
S3
IN
OUT
X GAIN
RV2
AMP
X SHIFT
RV3
RV4
RV5
RV6
L1 H.S.C.
L2 V.S.C.
C1 10mF
C2 3.3mF
C3 10mF
C4 5mF
C5 5mF
HV TO CRT CAP
TO CRT COATING
BUS-BAR
RV7
RV8
RV9
X AMP
MARK INPUT
TO MARK INPUT (FRONT PANEL)

Fig. 6.1

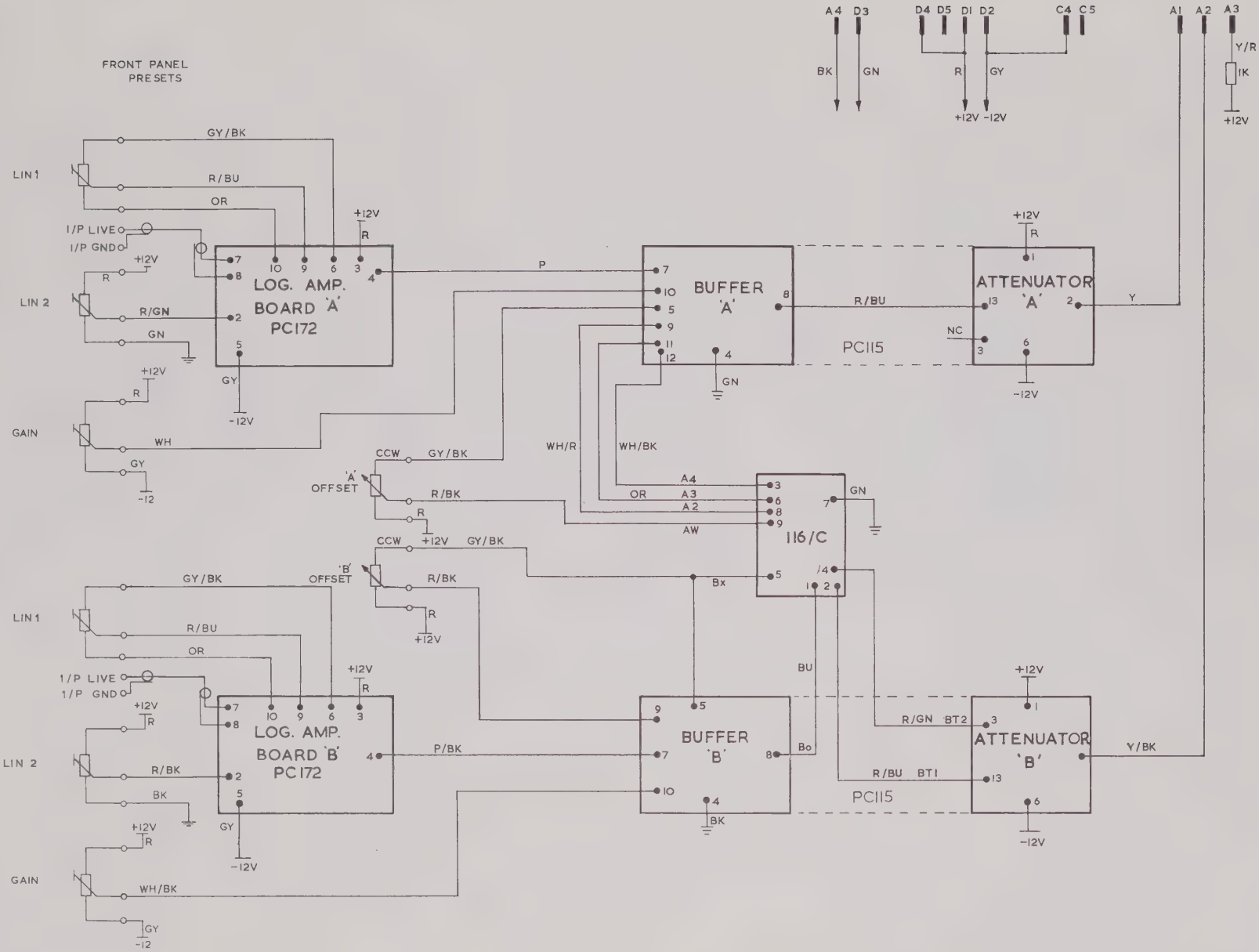

FRONT PANEL
PRESETS
A4 D3
BK GN
D4 D5 DI D2 C4 C5
R GY
+12V -12V
A1 A2 A3
Y/R
1K
+12V
GY/BK
LIN1
R/BU
OR
I/P LIVE
I/P GND
+12V
R
LOG. AMP.
BOARD 'A'
PC172
LIN 2
R/GN
GN
GY
-12V
GAIN
WH
GY
-12
P
BUFFER
'A'
PC115
R/BU
ATTENUATOR
'A'
NC
Y
GN
-12V
CCW
GY/BK
'A'
OFFSET
R/BK
WH/R
WH/BK
A4
OR A3
A2
AW
116/C
GN
'B'
OFFSET
Bx
BU
LOG. AMP.
BOARD 'B'
PC172
P/BK
BUFFER
'B'
Bo
R/GN BT2
R/BU BT1
ATTENUATOR
'B'
Y/BK
BK

Fig. 6.2

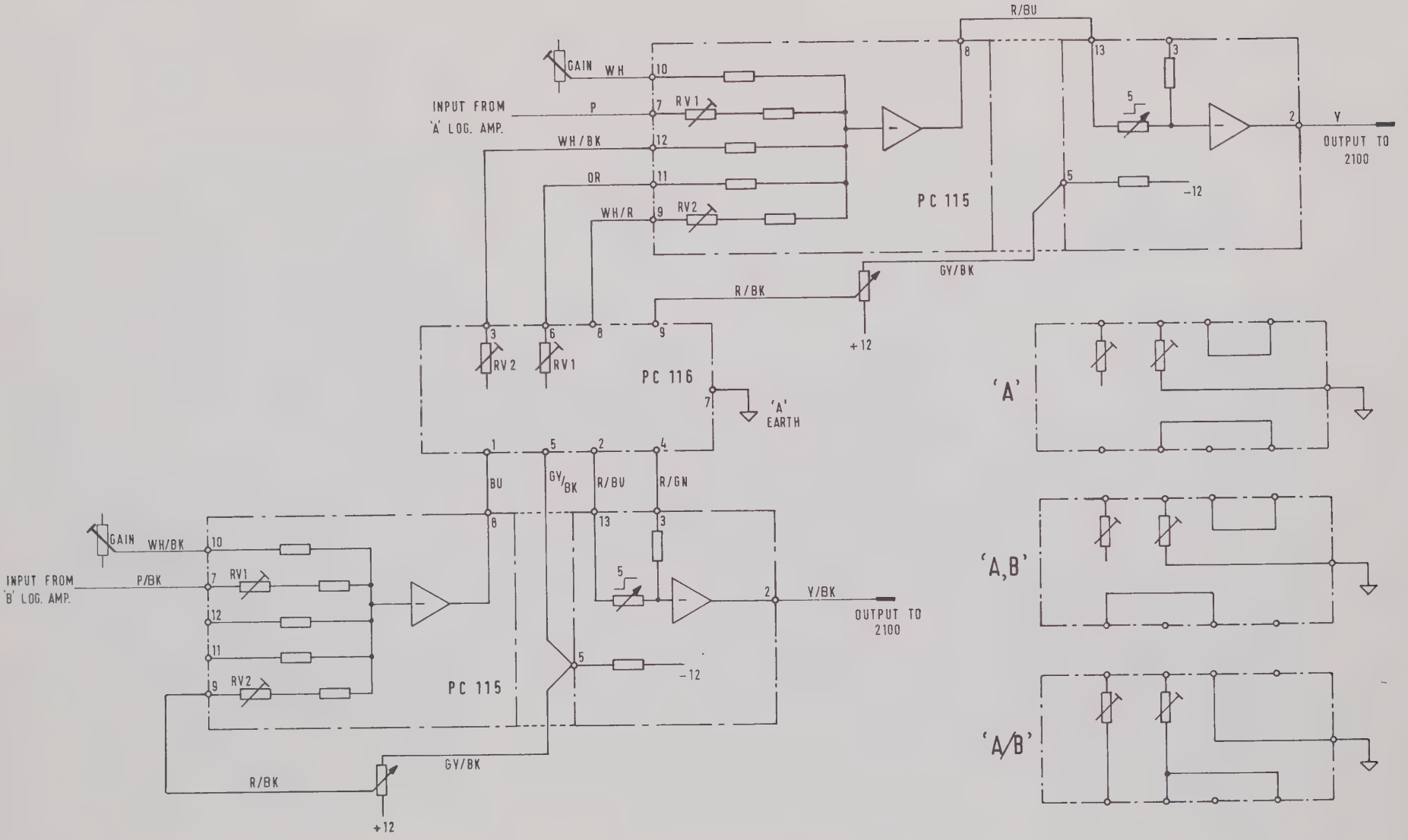

R/BU
GAIN WH
10
INPUT FROM
'A' LOG. AMP.
P
7
RV1
WH/BK
12
OR
11
WH/R
9
RV2
8
13
3
5
2
Y
OUTPUT TO
2100
PC 115
5
-12
GY/BK
R/BK
+12
3
6
8
9
RV2
RV1
PC 116
7
'A'
EARTH
1
5
2
4
BU
GY/BK
R/BU
R/GN
GAIN WH/BK
10
INPUT FROM
'B' LOG. AMP.
P/BK
7
RV1
12
11
9
RV2
8
13
3
5
2
Y/BK
OUTPUT TO
2100
PC 115
5
-12
GY/BK
R/BK
+12
'A'
'A,B'
'A/B'

Fig. 6.3

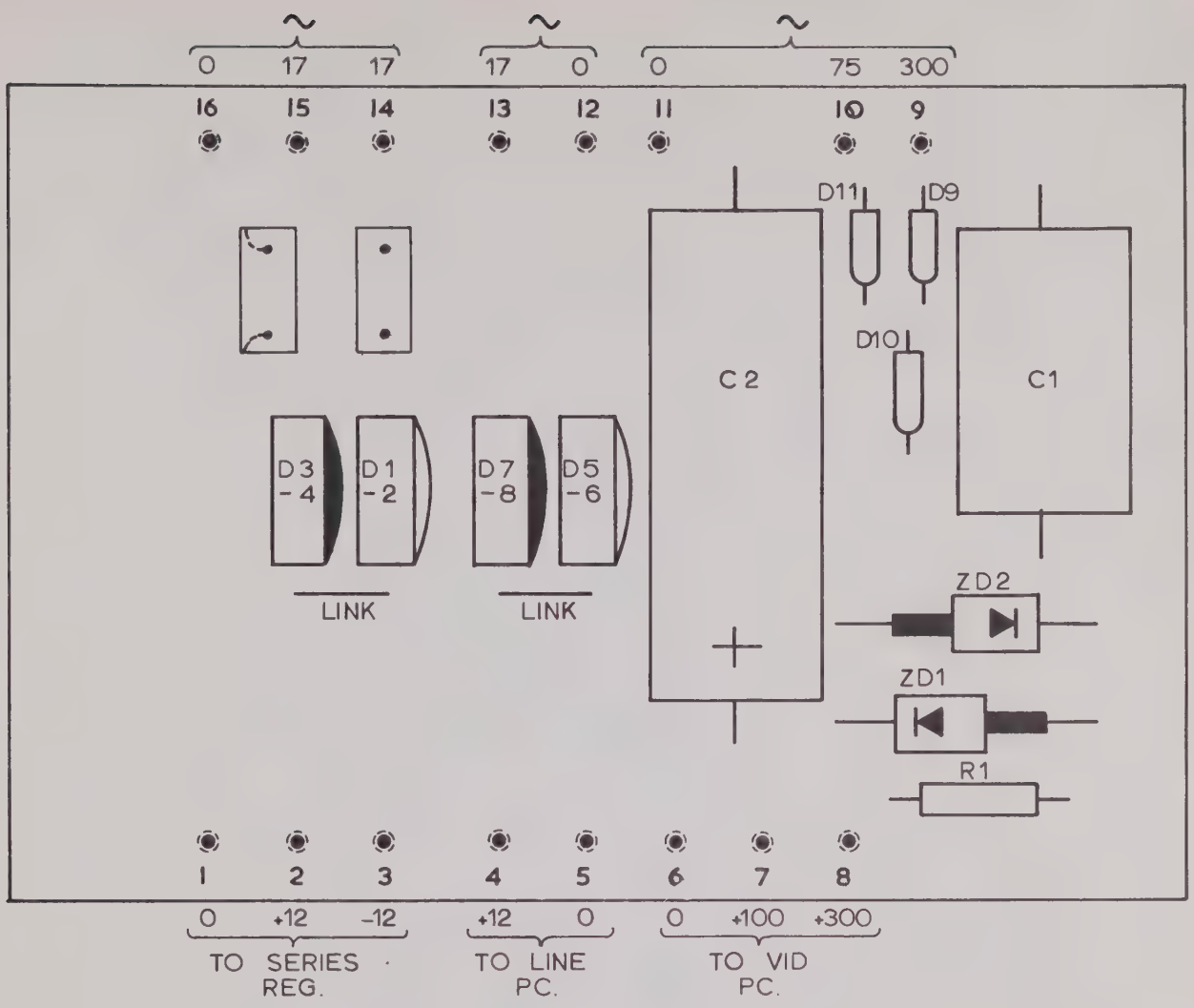

0 17 17
17 0
0 75 300
16 15 14 13 12 11 10 9
D11
D9
D10
C2
C1
D3 -4
D1 -2
D7 -8
D5 -6
LINK
LINK
ZD2
ZD1
R1
1 2 3 4 5 6 7 8
0 +12 -12
+12 0
0 +100 +300
TO SERIES REG.
TO LINE PC.
TO VID PC.

Fig. 6.4

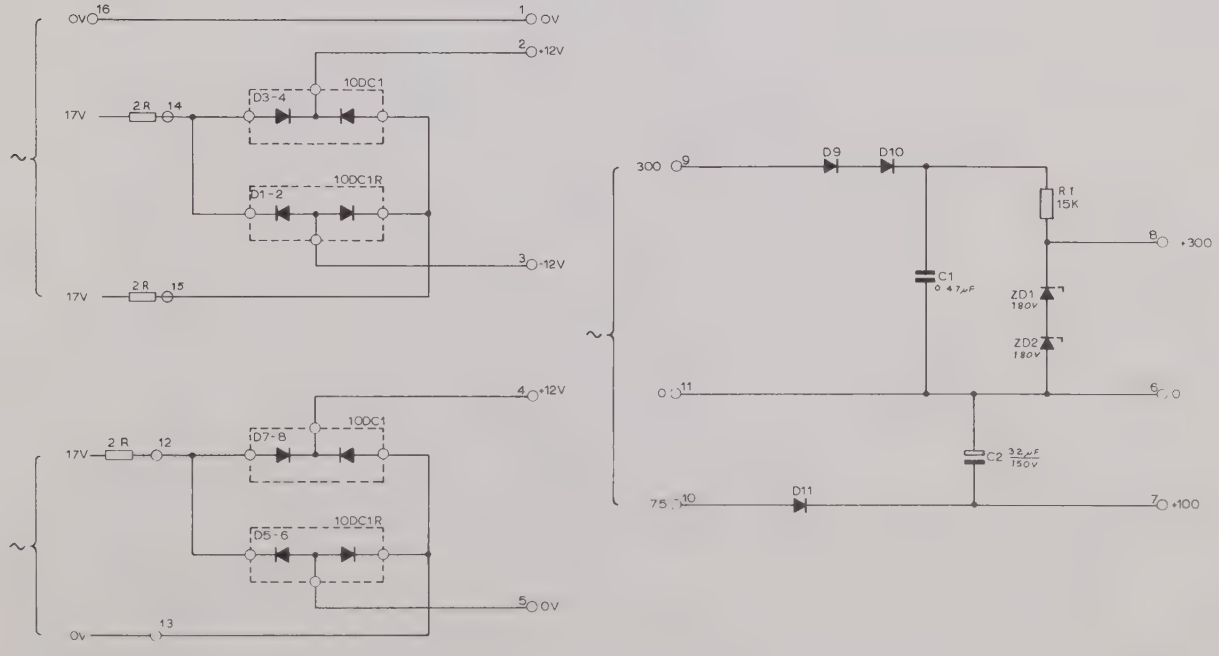

0V 16
1 0V
2 +12V
17V
2R 14
D3-4
10DC1
D1-2
10DC1R
3 -12V
17V
2R 15
4 +12V
17V
2R 12
D7-8
10DC1
D5-6
10DC1R
5 0V
0V 13
300 9
D9
D10
R1 15K
8 +300
C1 0.47μF
ZD1 180V
ZD2 180V
0 11
6 0
C2 32μF 150V
75 10
D11
7 +100

Fig. 6.5

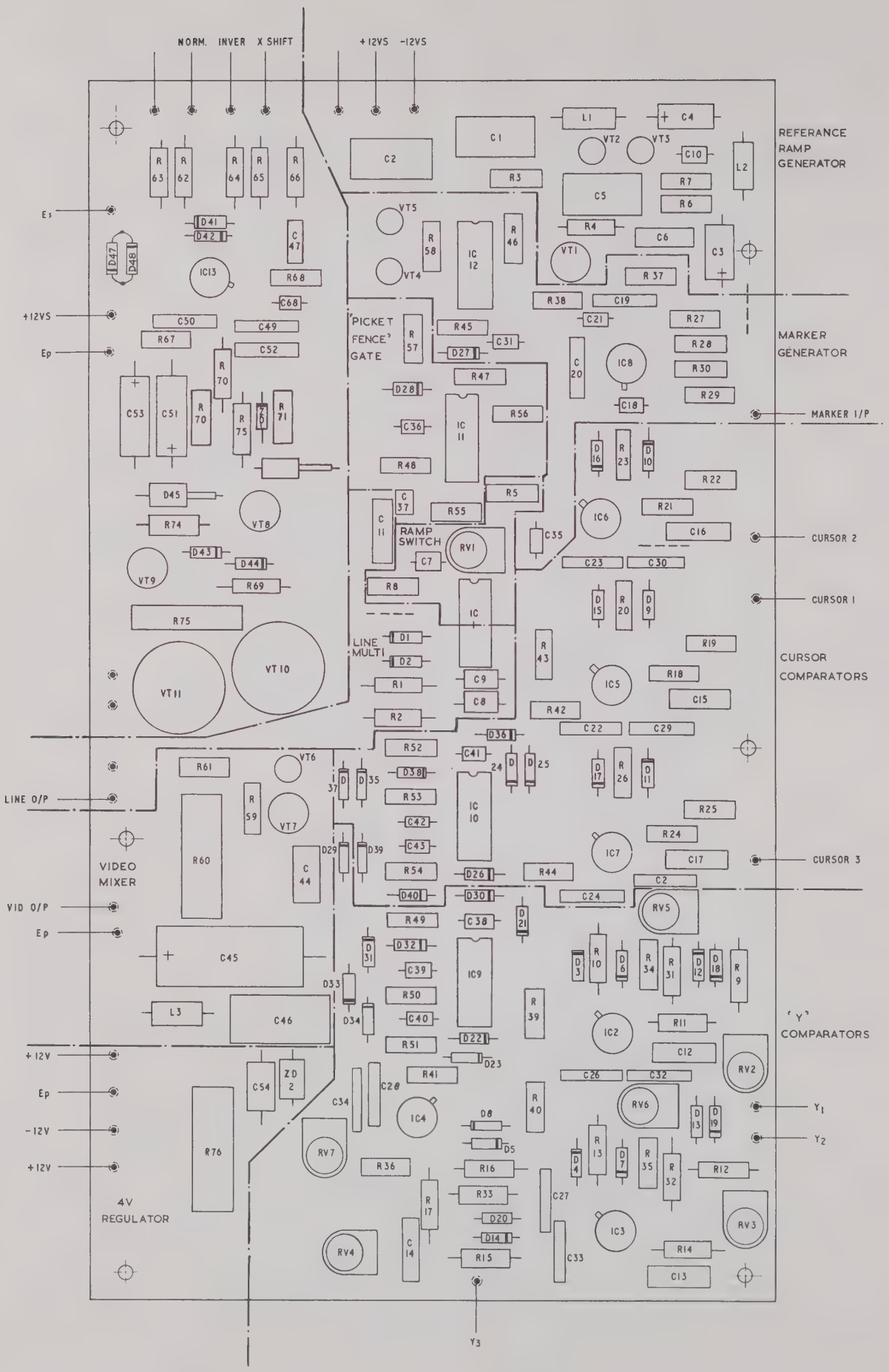

NORM.
INVER
X SHIFT
+12VS
-12VS
REFERANCE RAMP GENERATOR
MARKER GENERATOR
MARKER I/P
CURSOR 2
CURSOR 1
CURSOR COMPARATORS
CURSOR 3
'Y' COMPARATORS
Y1
Y2
Y3
'PICKET FENCE' GATE
RAMP SWITCH
LINE MULTI
VIDEO MIXER
LINE O/P
VID O/P
4V REGULATOR
Es
Ep
+12VS
+12V
-12V
+12V

Fig. 6.6

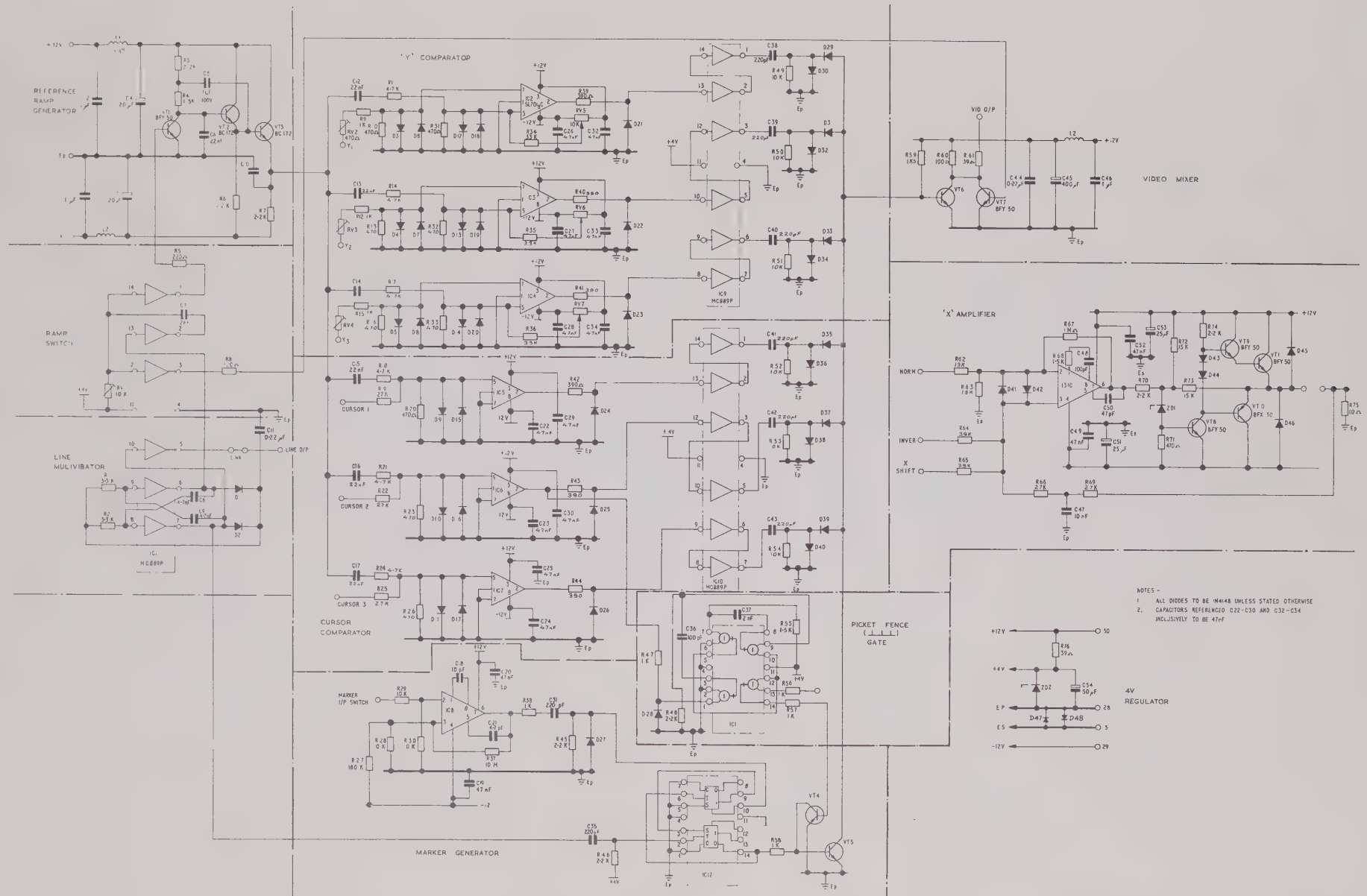
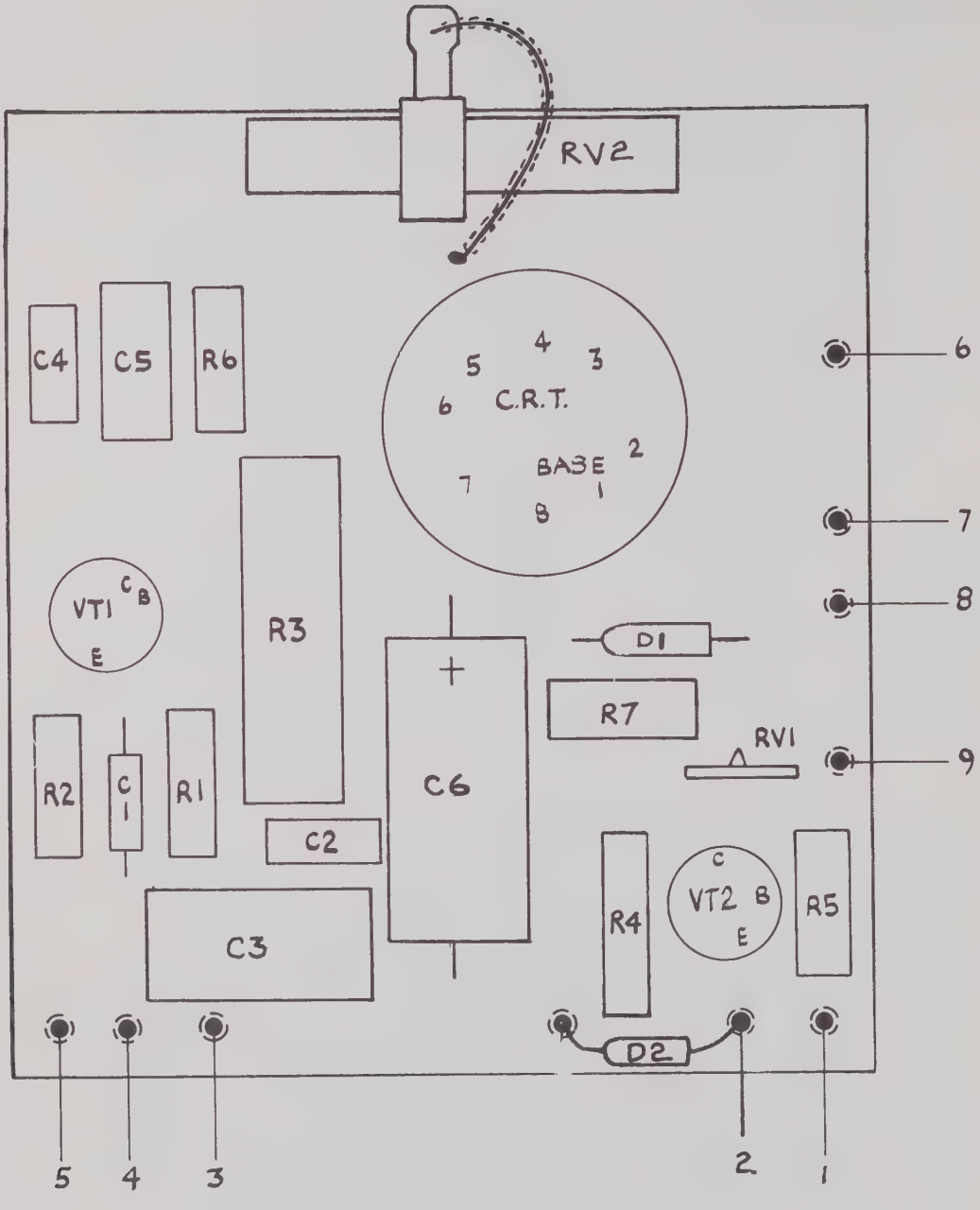

REFERENCE RAMP GENERATOR
'Y' COMPARATOR
VIDEO MIXER
VID O/P
'X' AMPLIFIER
RAMP SWITCH
LINE MULIVIBATOR
LINE O/P
CURSOR 1
CURSOR 2
CURSOR 3
CURSOR COMPARATOR
PICKET FENCE GATE
MARKER I/P SWITCH
MARKER GENERATOR
4V REGULATOR
NORM
INVER
X SHIFT
NOTES -
1. ALL DIODES TO BE IN4148 UNLESS STATED OTHERWISE
2. CAPACITORS REFERENCED D22-C30 AND C32-C34 INCLUSIVELY TO BE 47nF

Fig. 6.7


RV2
C4
C5
R6
C.R.T.
BASE
R3
VT1
C
B
E
D1
R7
RV1
R2
C1
R1
C6
C2
C3
R4
VT2
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B
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R5
D2
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8
9
5
4
3
2
1

Fig. 6.8

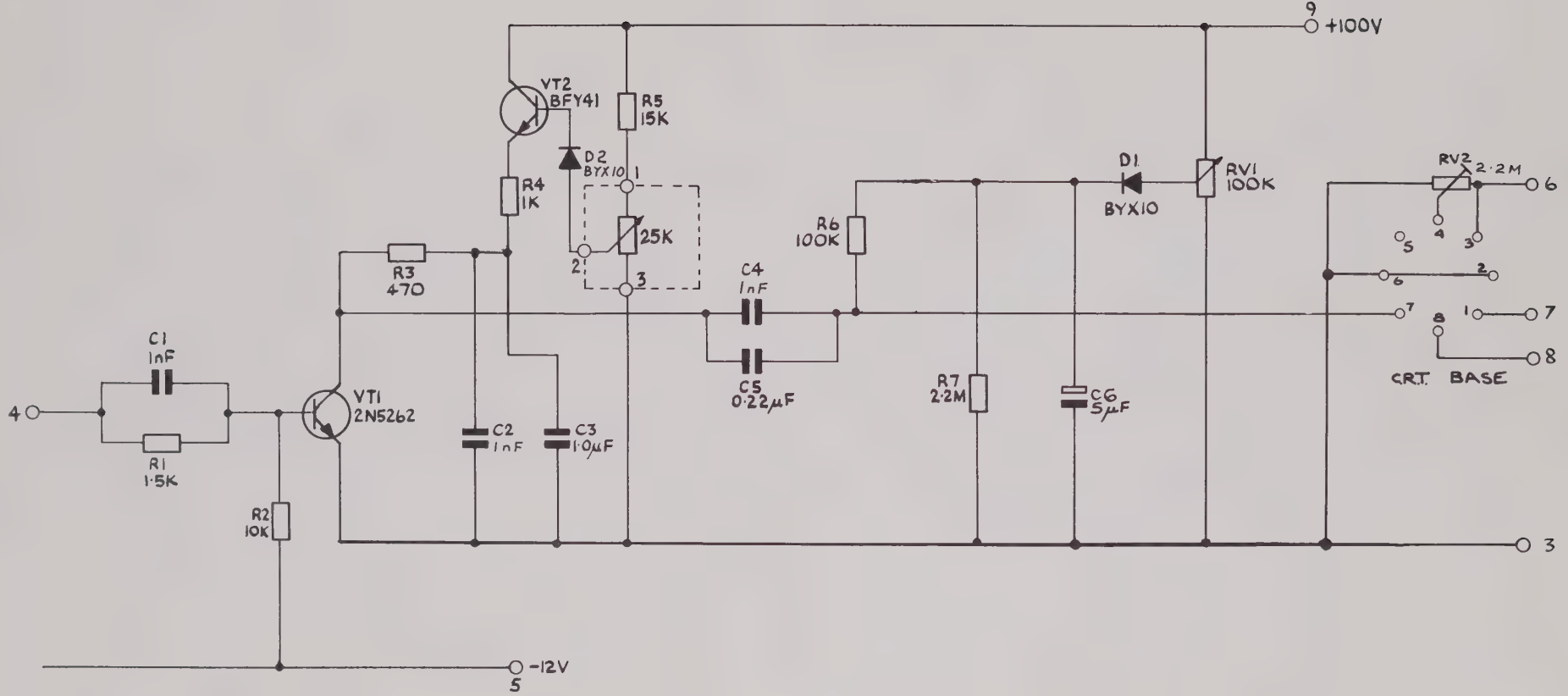

9
+100V
VT2
BFY41
R5
15K
D2
BYX10
1
R4
1K
25K
2
3
R3
470
C4
1nF
R6
100K
D1
BYX10
RV1
100K
RV2
2·2M
6
5
4
3
6
2
7
1
7
8
8
CRT BASE
C1
1nF
4
VT1
2N5262
C2
1nF
C3
1·0μF
C5
0·22μF
R7
2·2M
C6
5μF
R1
1·5K
R2
10K
3
-12V
5

Fig. 6.9

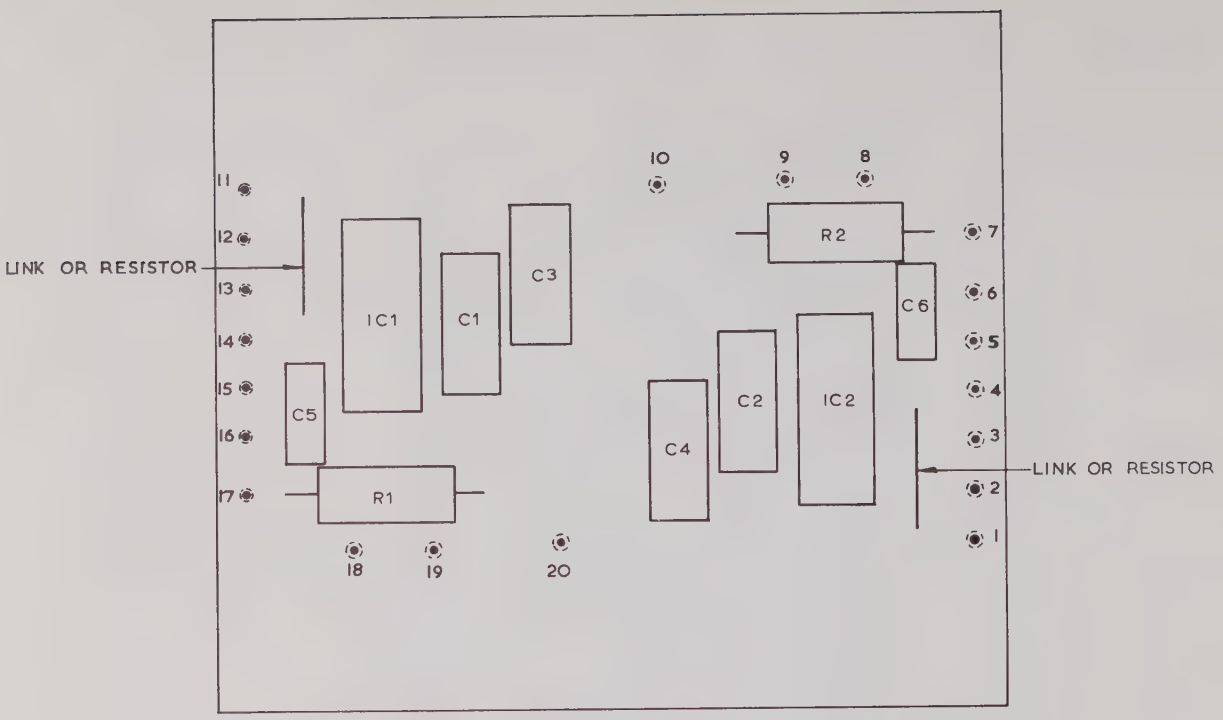


Fig. 6.10

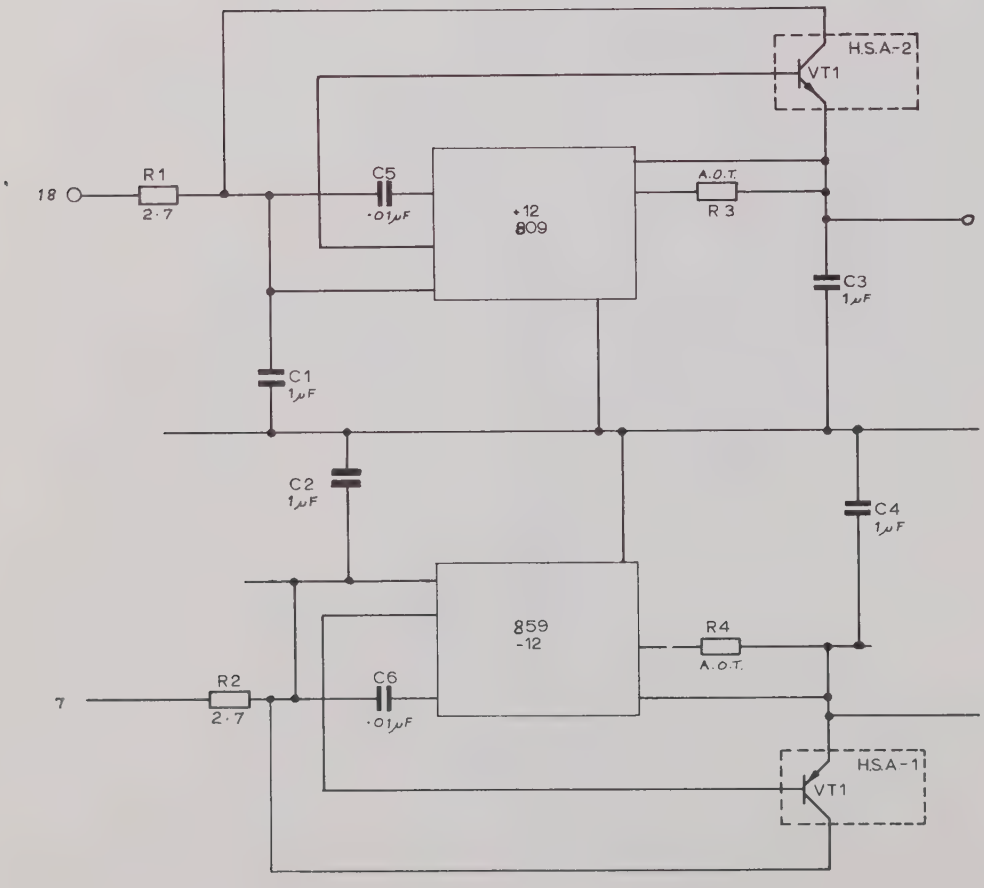


Fig. 6.11

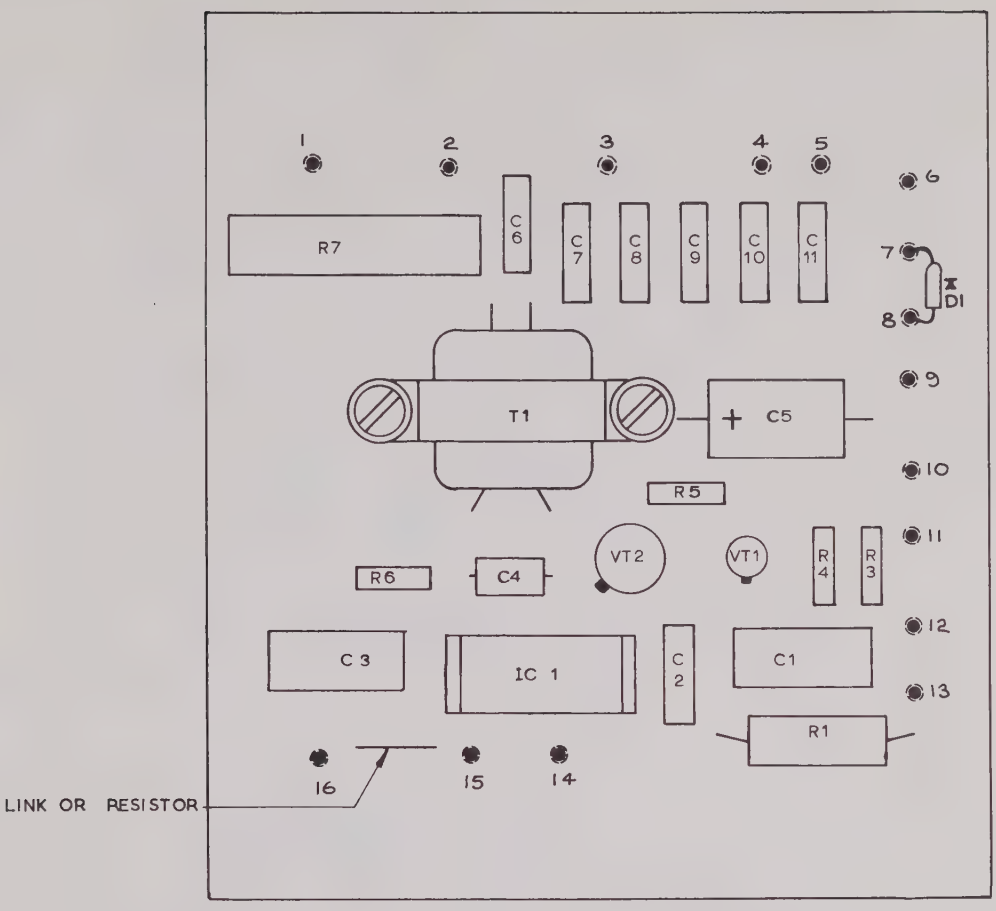


Fig. 6.12

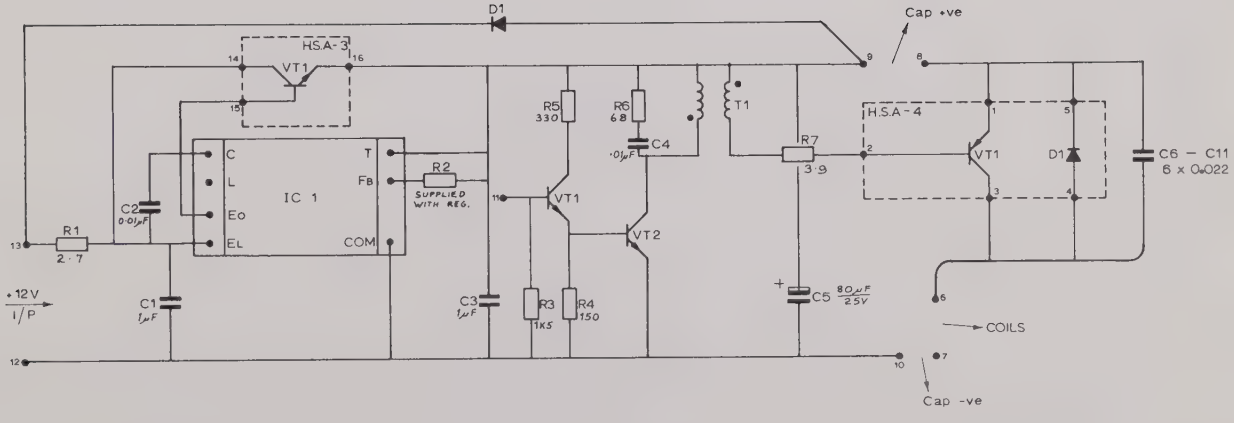


Fig. 6.13

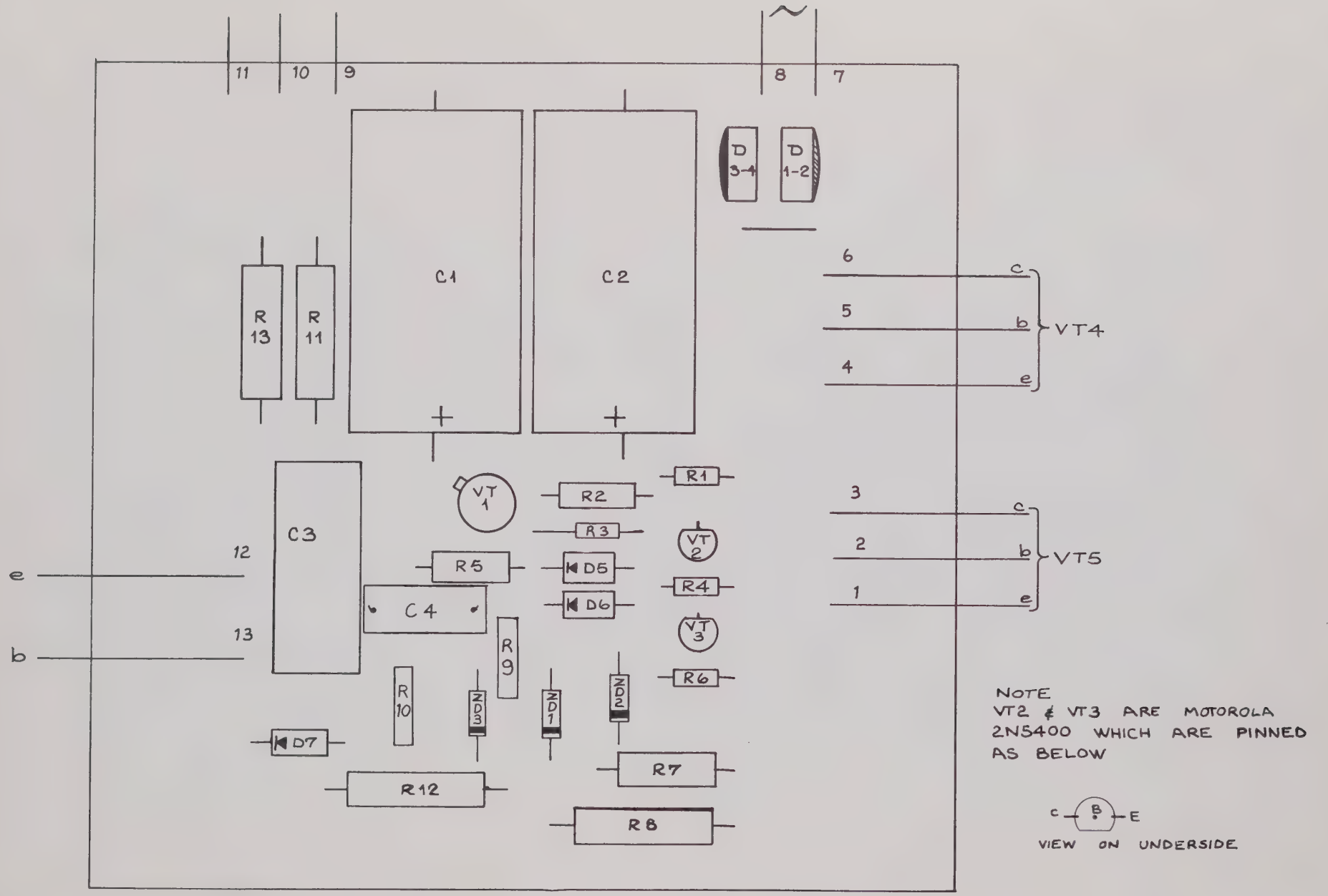

11
10
9
8
7
D 3-4
D 1-2
C1
C2
R 13
R 11
6
c
5
b
4
e
VT4
C3
12
e
13
b
VT 1
R2
R1
R3
VT 2
R5
D5
R4
C 4
D6
VT 3
R 9
R6
R 10
ZD3
ZD1
ZD2
D7
R7
R12
R8
3
c
2
b
1
e
VT5
NOTE
VT2 & VT3 ARE MOTOROLA 2N5400 WHICH ARE PINNED AS BELOW
c
B
E
VIEW ON UNDERSIDE

Fig. 6.14

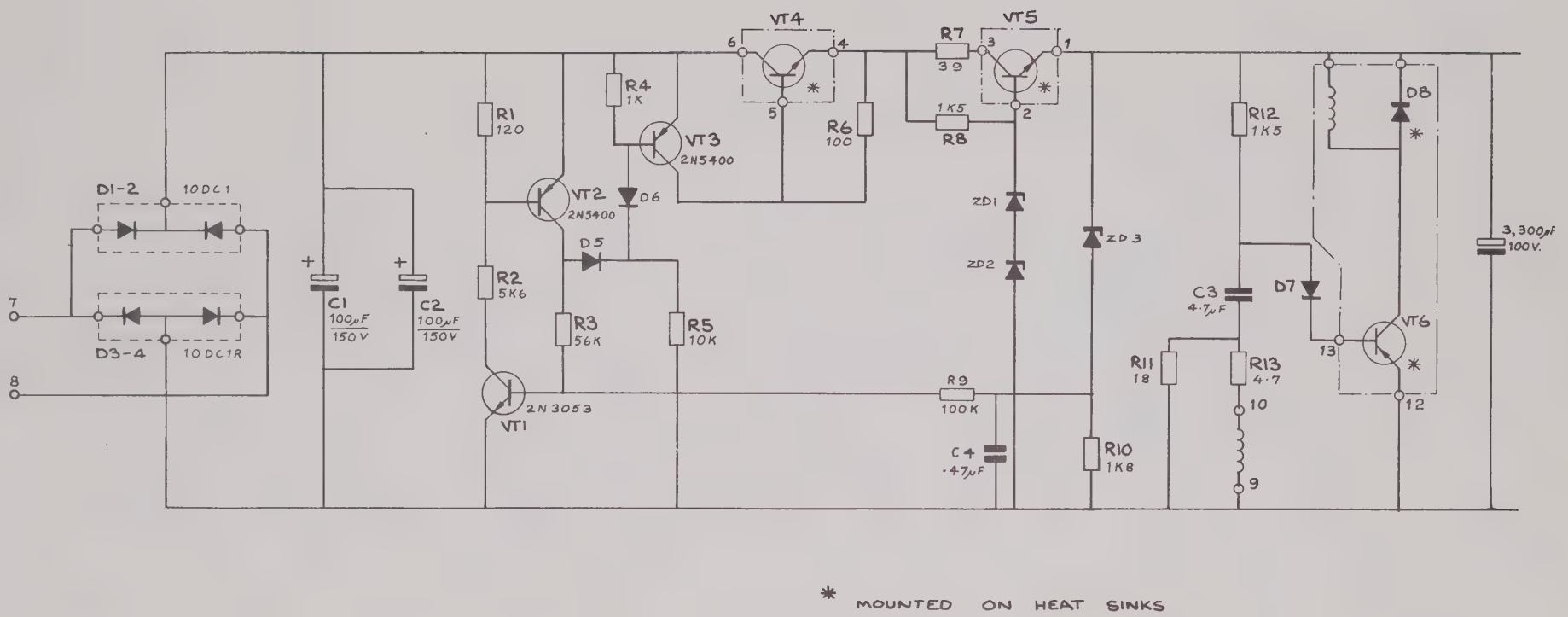

D1-2
10DC1
D3-4
10DC1R
7
8
C1
100μF
150V
C2
100μF
150V
R1
120
R2
5K6
R3
56K
R4
1K
R5
10K
R6
100
R7
39
R8
1K5
R9
100K
R10
1K8
R11
18
R12
1K5
R13
4·7
C3
4·7μF
C4
·47μF
VT1
2N3053
VT2
2N5400
VT3
2N5400
VT4
VT5
VT6
D5
D6
D7
D8
ZD1
ZD2
ZD3
3,300μF
100V.
* MOUNTED ON HEAT SINKS

Fig. 6.15

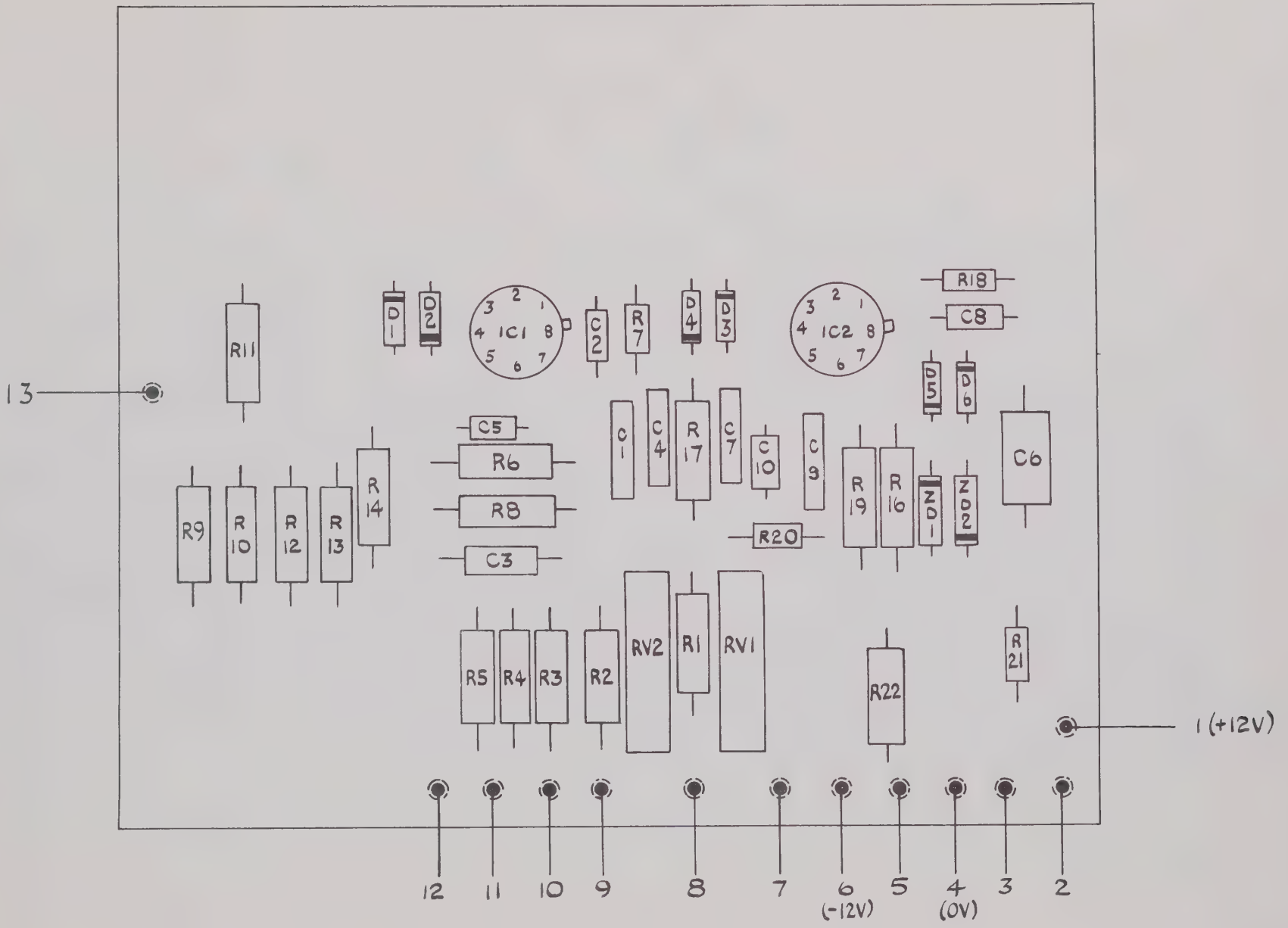

13
R11
D1
D2
IC1
C2
R7
D4
D3
IC2
R18
C8
D5
D6
C5
R6
R8
C3
C1
C4
R17
C7
C10
C9
R19
R16
ZD1
ZD2
C6
R20
R9
R10
R12
R13
R14
R5
R4
R3
R2
RV2
R1
RV1
R22
R21
1 (+12V)
12
11
10
9
8
7
6
(-12V)
5
4
(0V)
3
2

Fig. 6.16

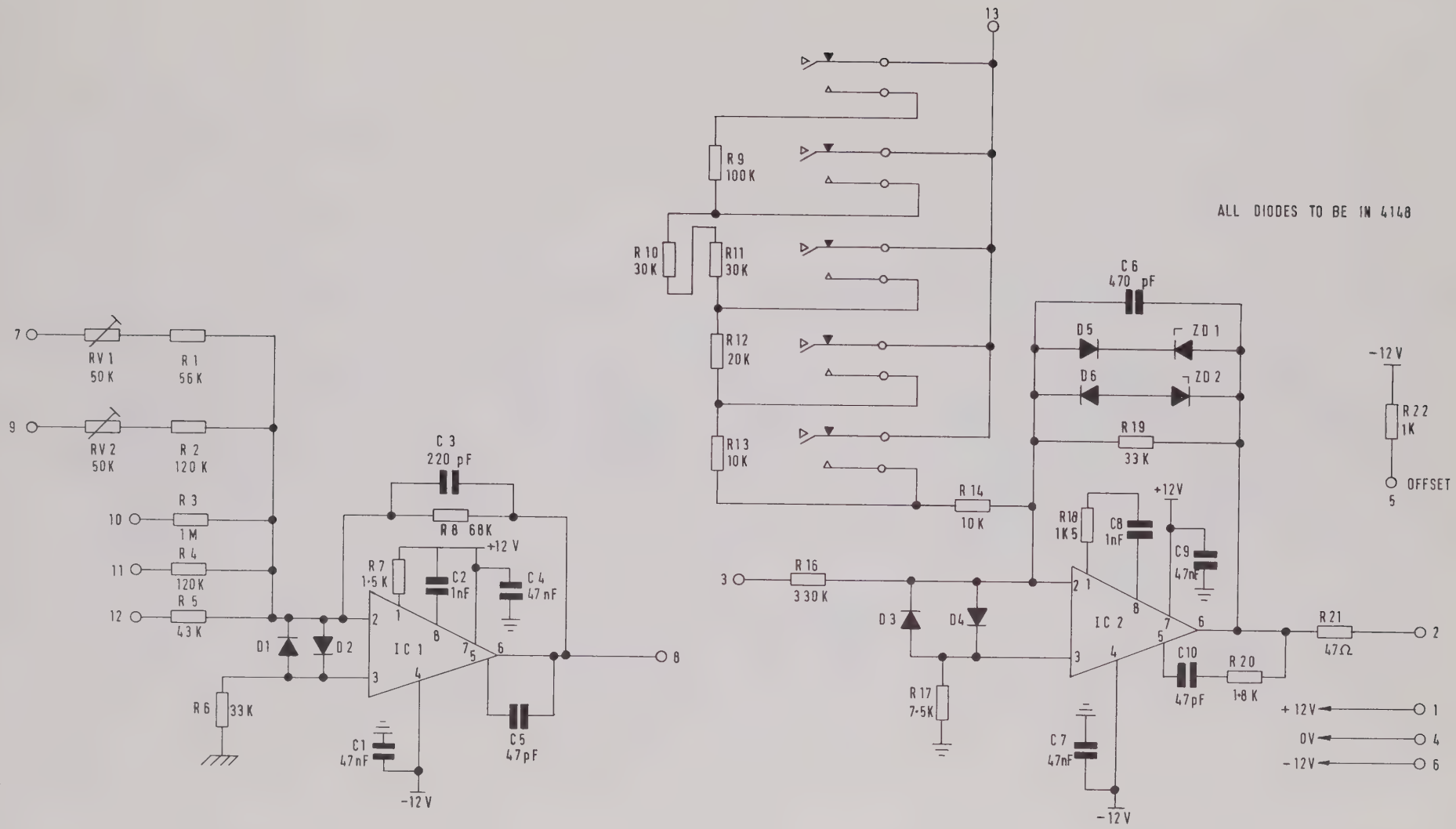
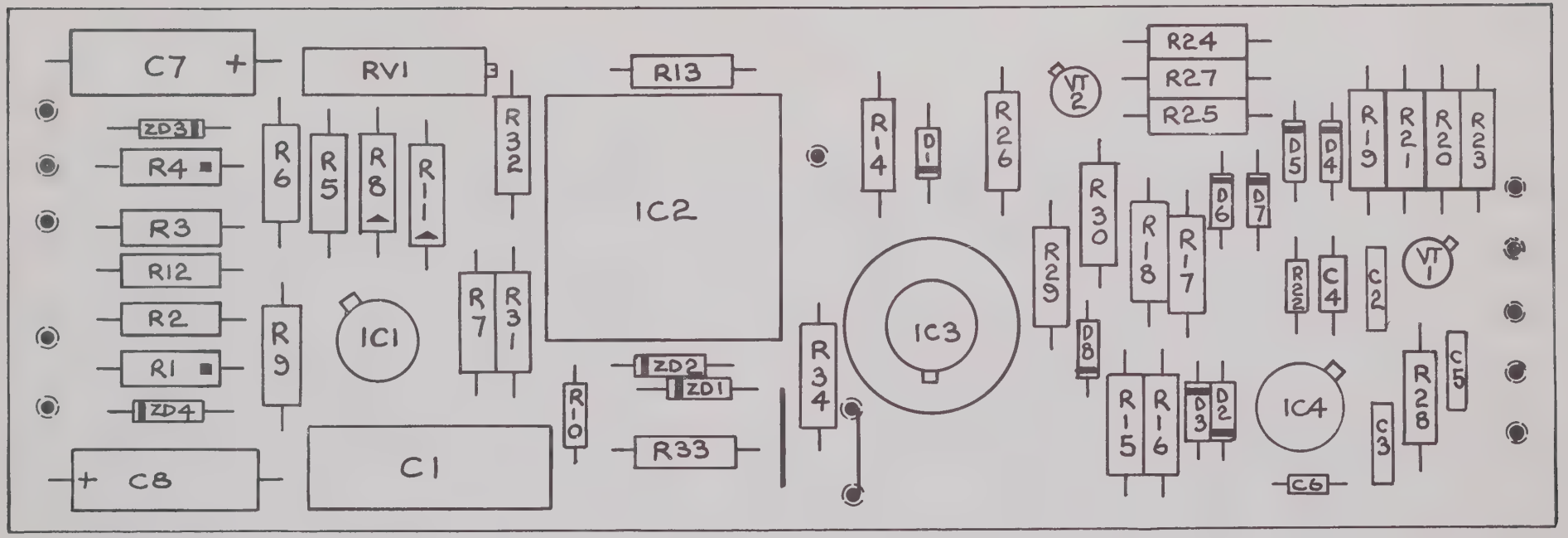

ALL DIODES TO BE IN 4148
7
9
10
11
12
13
3
RV 1
50 K
R 1
56 K
RV 2
50K
R 2
120 K
R 3
1M
R 4
120K
R 5
43 K
R 6
33 K
R 7
1·5 K
R 8 68K
R 9
100 K
R 10
30K
R11
30K
R12
20K
R13
10K
R 14
10 K
R 16
330 K
R 17
7·5K
R18
1K5
R19
33 K
R 20
1·8 K
R21
47Ω
R22
1K
C 3
220 pF
C1
47nF
C2
1nF
C 4
47 nF
C5
47pF
C6
470 pF
C7
47nF
C8
1nF
C9
47nF
C10
47pF
D1
D2
D3
D4
D5
D6
ZD 1
ZD 2
IC 1
IC 2
+12 V
-12 V
OFFSET
5
8
2
1
4
0V
6

Fig. 6.17



MATCHED PAIRS OF RESISTORS

Fig. 6.18

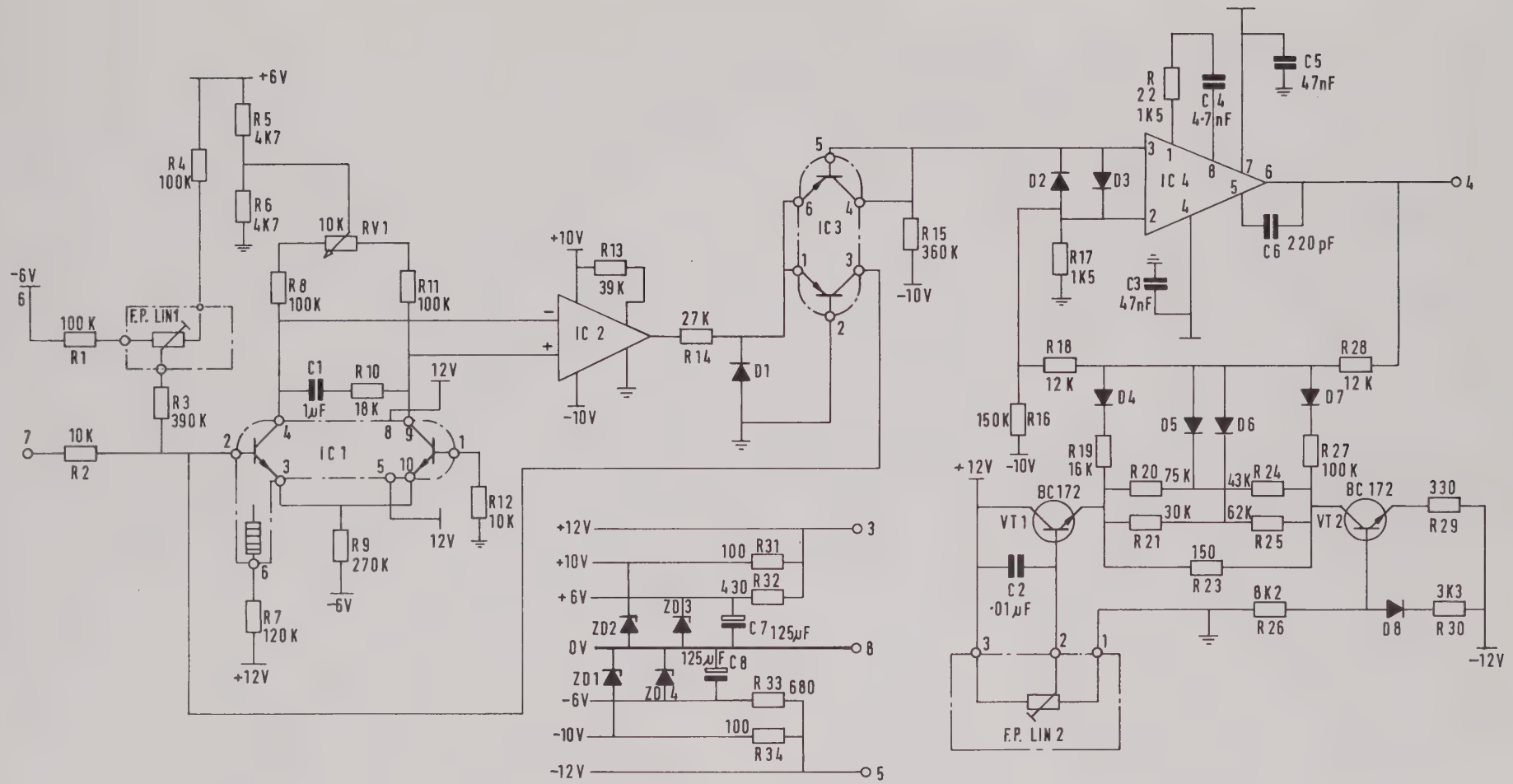

+6V
R5 4K7
R4 100K
R6 4K7
10K RV1
-6V
6
100K R1
F.P. LIN1
R8 100K
R11 100K
R3 390K
7
10K R2
C1 1µF
R10 18K
12V
IC 1
R12 10K
R9 270K
-6V
6
R7 120K
+12V
+10V
R13 39K
IC 2
27K R14
-10V
D1
5
IC 3
6
4
1
3
2
R15 360K
-10V
+12V
3
100 R31
+10V
430 R32
+6V
ZD3
ZD2
C7 125µF
0V
8
125µF C8
ZD1
ZD4
-6V
R33 680
-10V
100 R34
-12V
5
R 22 1K5
C4 4·7nF
C5 47nF
D2
D3
IC 4
4
C6 220 pF
R17 1K5
C3 47nF
R18 12K
R28 12K
150K R16
D4
D5
D6
D7
+12V
-10V
R19 16K
R20 75K
43K R24
R27 100K
BC172
VT1
30K R21
62K R25
BC 172
VT 2
330 R29
150 R23
C2 ·01µF
8K2 R26
D8
3K3 R30
-12V
F.P. LIN 2

Fig. 6.19

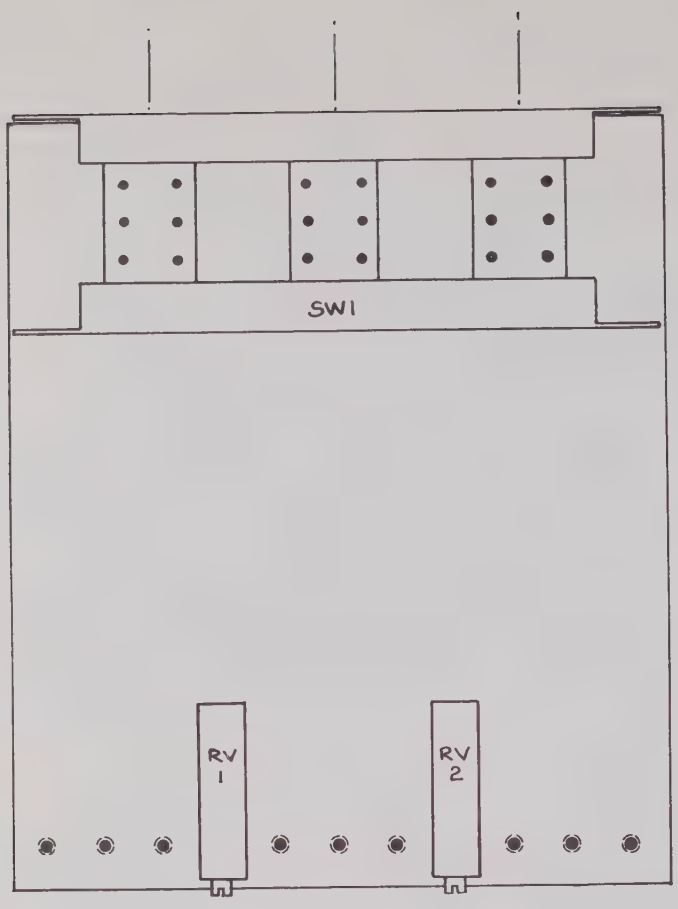


Fig. 6.20

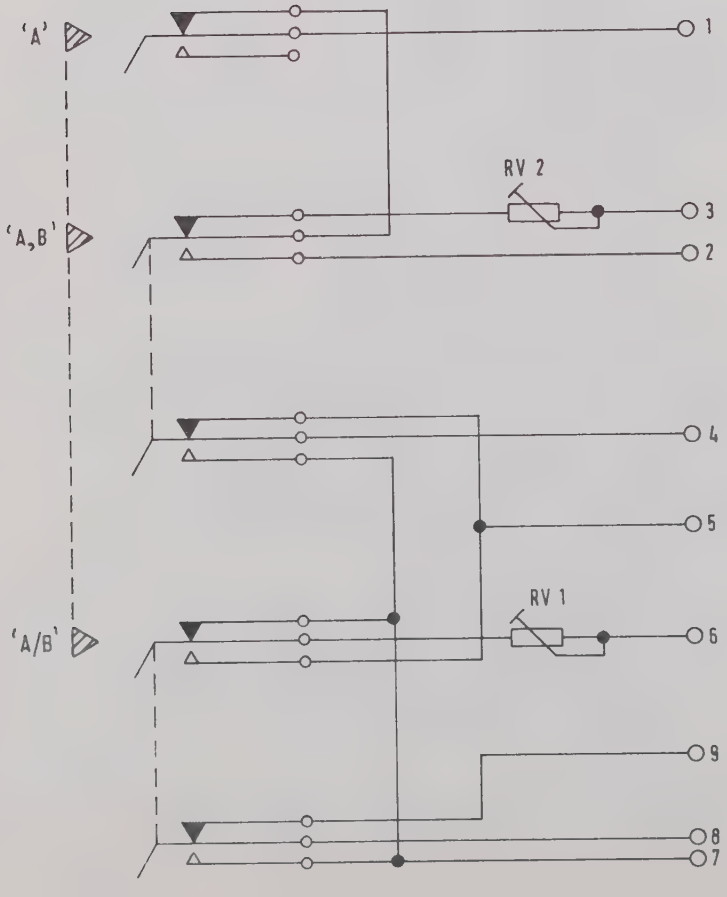


Fig. 6.21

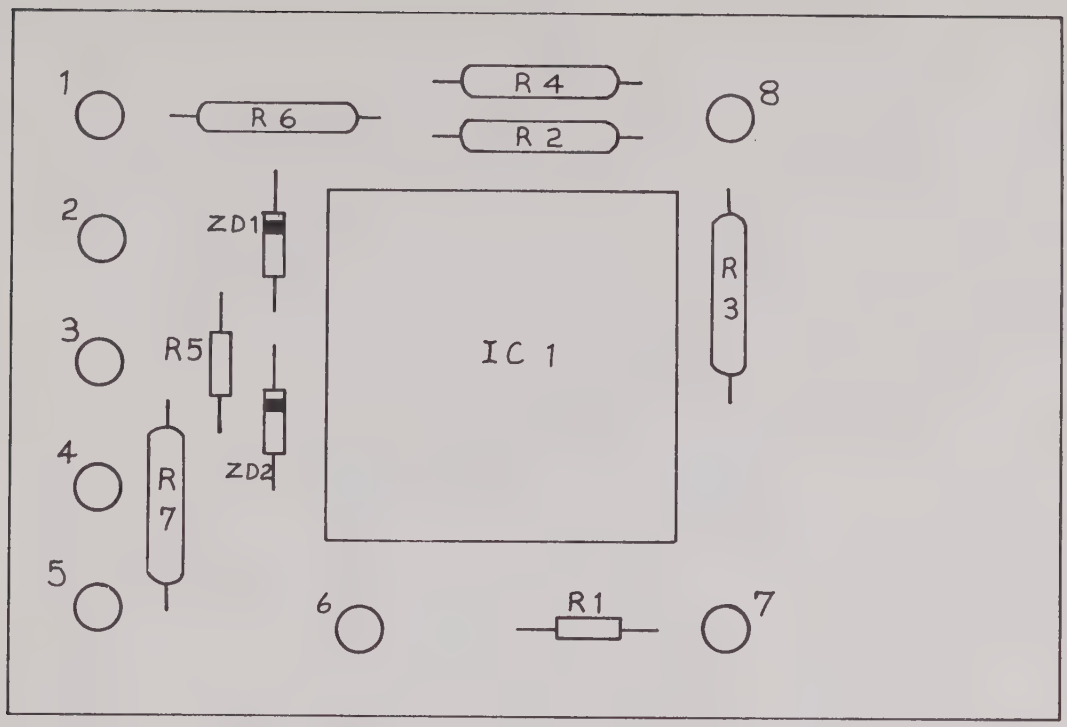


Fig. 6.22

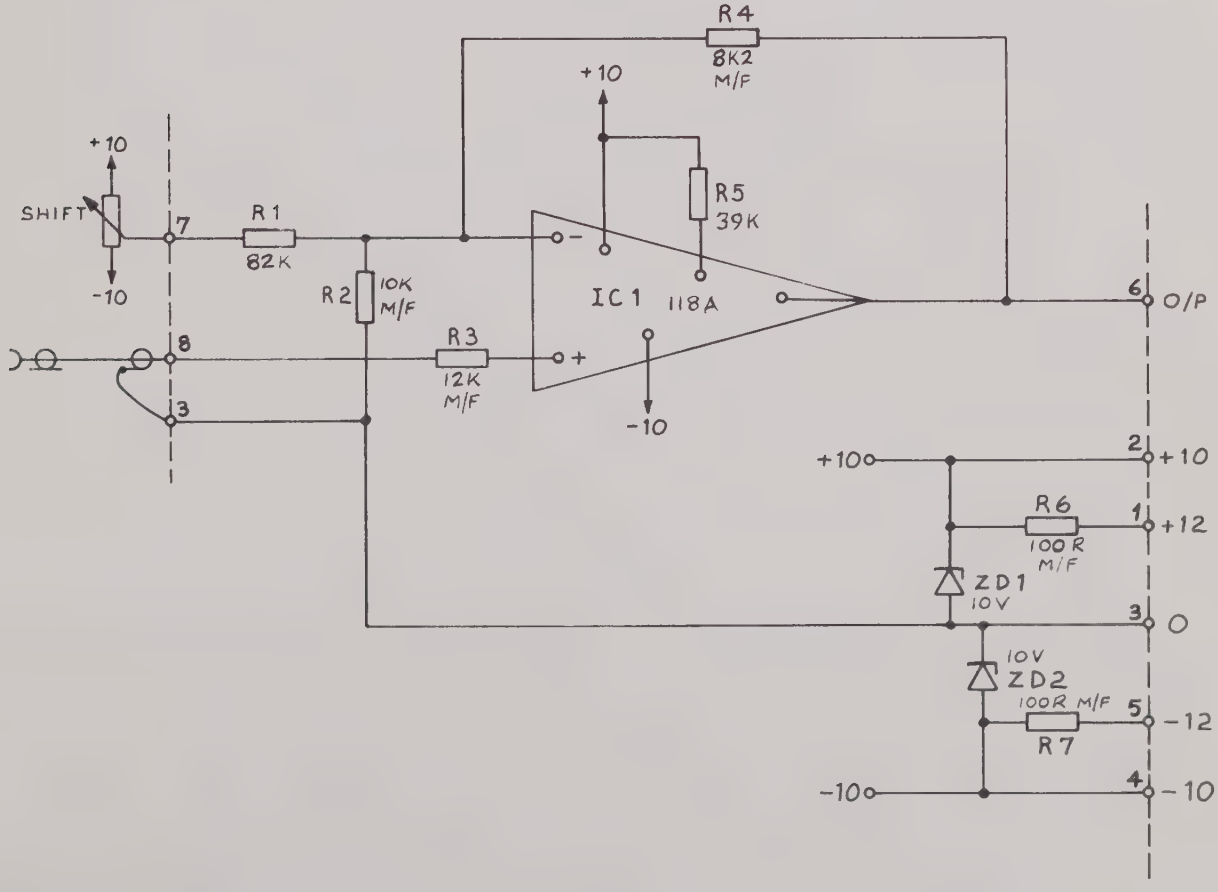


Fig. 6.23

The following Diagrams, Figures 6.24 to 6.37, apply to Display Units having 3-digit Serial Numbers :

Figure 6.24 2100 Mainframe Wiring Schematic Diagram

Mainframe PC Assemblies

6.25 PC108 Layout (Rectifier)
6.26 PC108 Circuit (Rectifier)
6.27 PC109 Layout (Line)
6.28 PC109 Circuit (Line)
6.29 PC113 Layout (EHT Driver)
6.30 PC113 Circuit (EHT Driver)

Module PC Assemblies

6.31 Circuit and Layout (Calibrator Switch)
6.32 PC131 Layout (Calibrator)
6.33 PC131 Circuit (Calibrator)
6.34 PC115 Layout (Attenuator)
6.35 PC115 Circuit (Attenuator)
6.36 PC112 Layout (Logarithmic Amplifier)
6.37 PC112 Circuit (Logarithmic Amplifier)

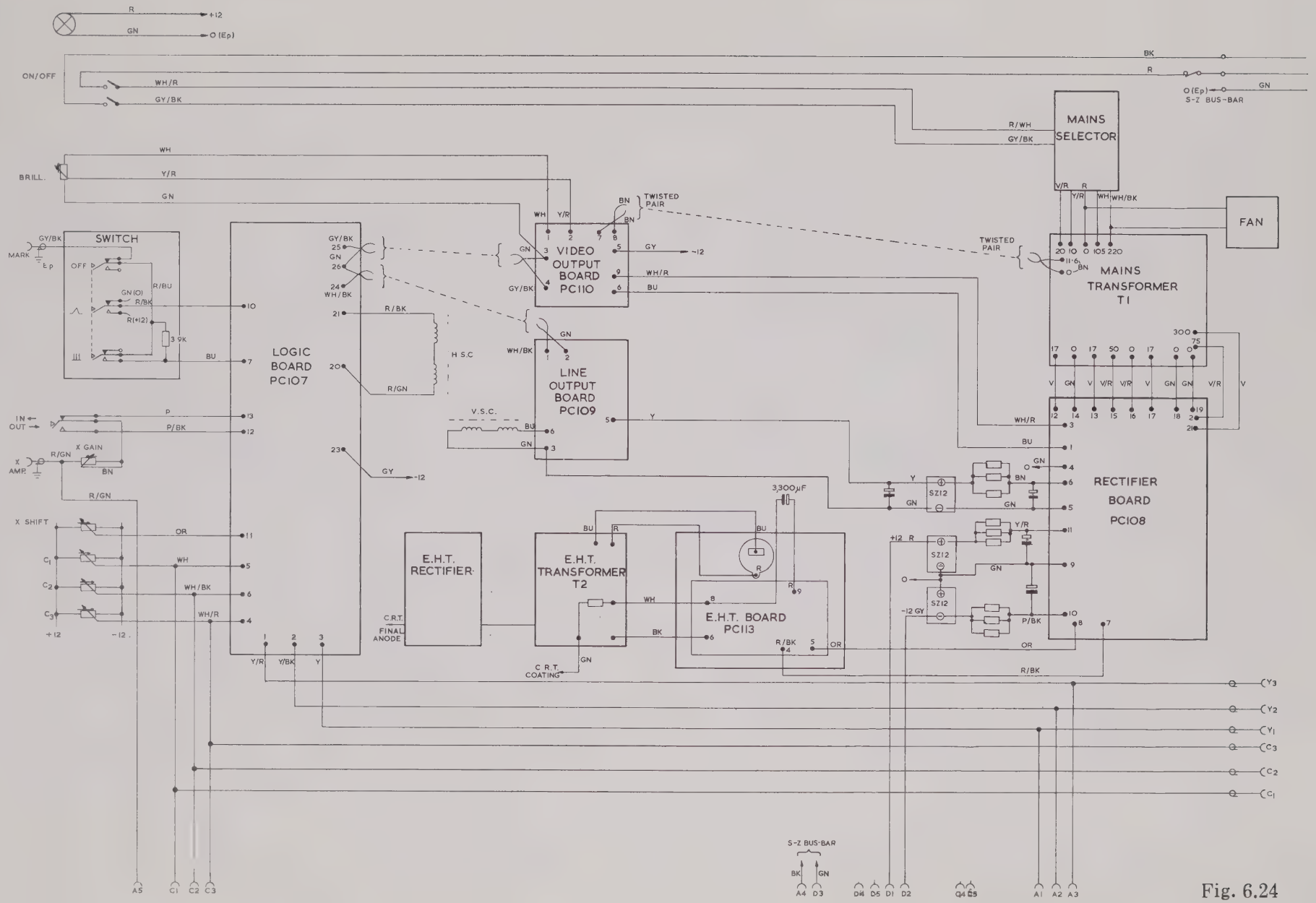

R
+12
GN
0 (Ep)
ON/OFF
WH/R
GY/BK
BK
R
0 (Ep)
GN
S-Z BUS-BAR
MAINS SELECTOR
R/WH
GY/BK
BRILL.
WH
Y/R
GN
SWITCH
MARK
Ep
OFF
GN (O)
R/BK
R(+12)
3.9K
R/BU
BU
LOGIC BOARD PC107
GY/BK
GN
WH/BK
R/BK
R/GN
H.S.C.
V.S.C.
GY
-12
VIDEO OUTPUT BOARD PC110
TWISTED PAIR
BN
WH
Y/R
GN
GY
WH/R
BU
LINE OUTPUT BOARD PC109
Y
FAN
MAINS TRANSFORMER T1
TWISTED PAIR
20 10 0 105 220
11-6
BN
300
75
17 0 17 50 0 17 0 0
V GN V V/R V/R V GN GN V/R V
12 14 13 15 16 17 18 19 2 21
IN OUT
P
P/BK
X AMP.
R/GN
X GAIN
BN
X SHIFT
C1
C2
C3
OR
WH
WH/BK
WH/R
+12
-12
Y/R
Y/BK
Y
RECTIFIER BOARD PC108
3,300μF
SZ12
E.H.T. RECTIFIER
C.R.T. FINAL ANODE
E.H.T. TRANSFORMER T2
E.H.T. BOARD PC113
C.R.T. COATING
R/BK
OR
Y3
Y2
Y1
C3
C2
C1
A5
C1
C2
C3
S-Z BUS-BAR
BK
GN
A4
D3
D4
D5
D1
D2
Q4
Q5
A1
A2
A3

Fig. 6.24

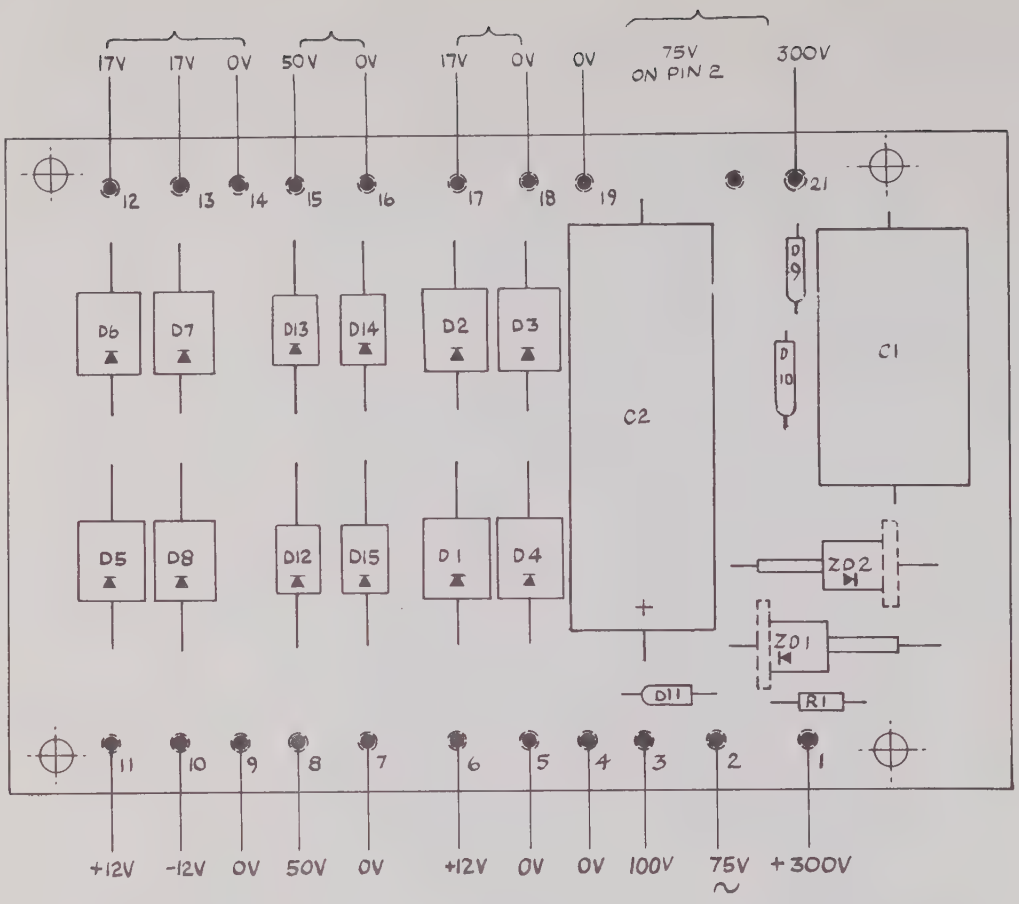


Fig. 6.25

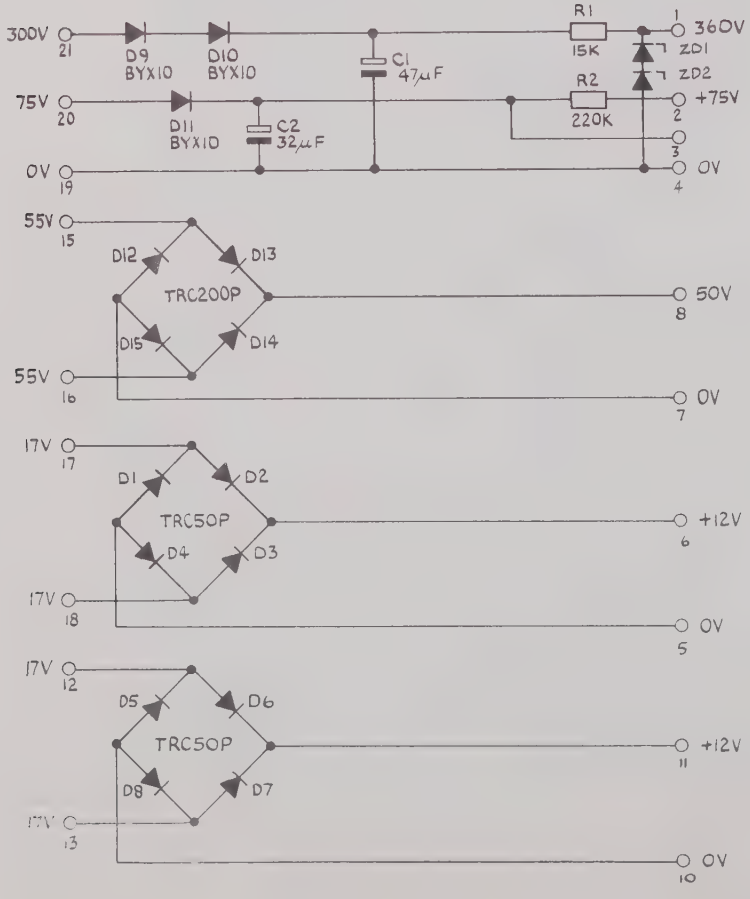


Fig. 6.26

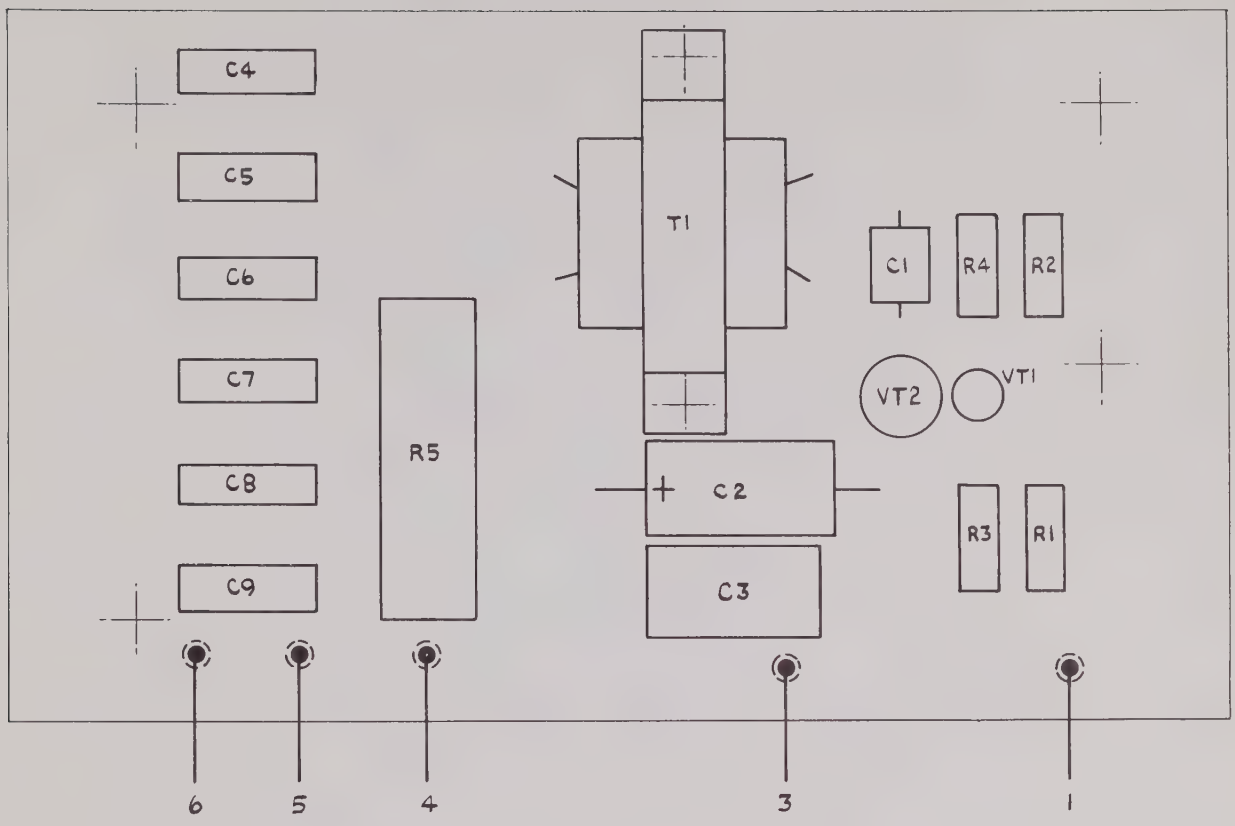


Fig. 6.27

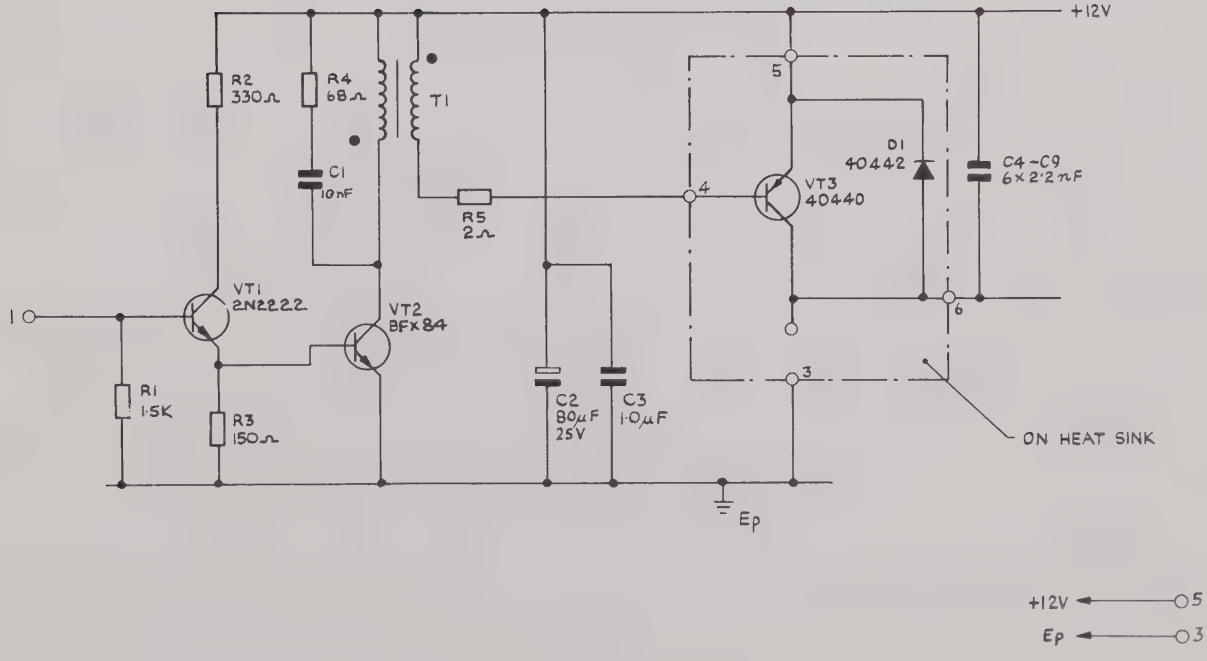


Fig. 6.28

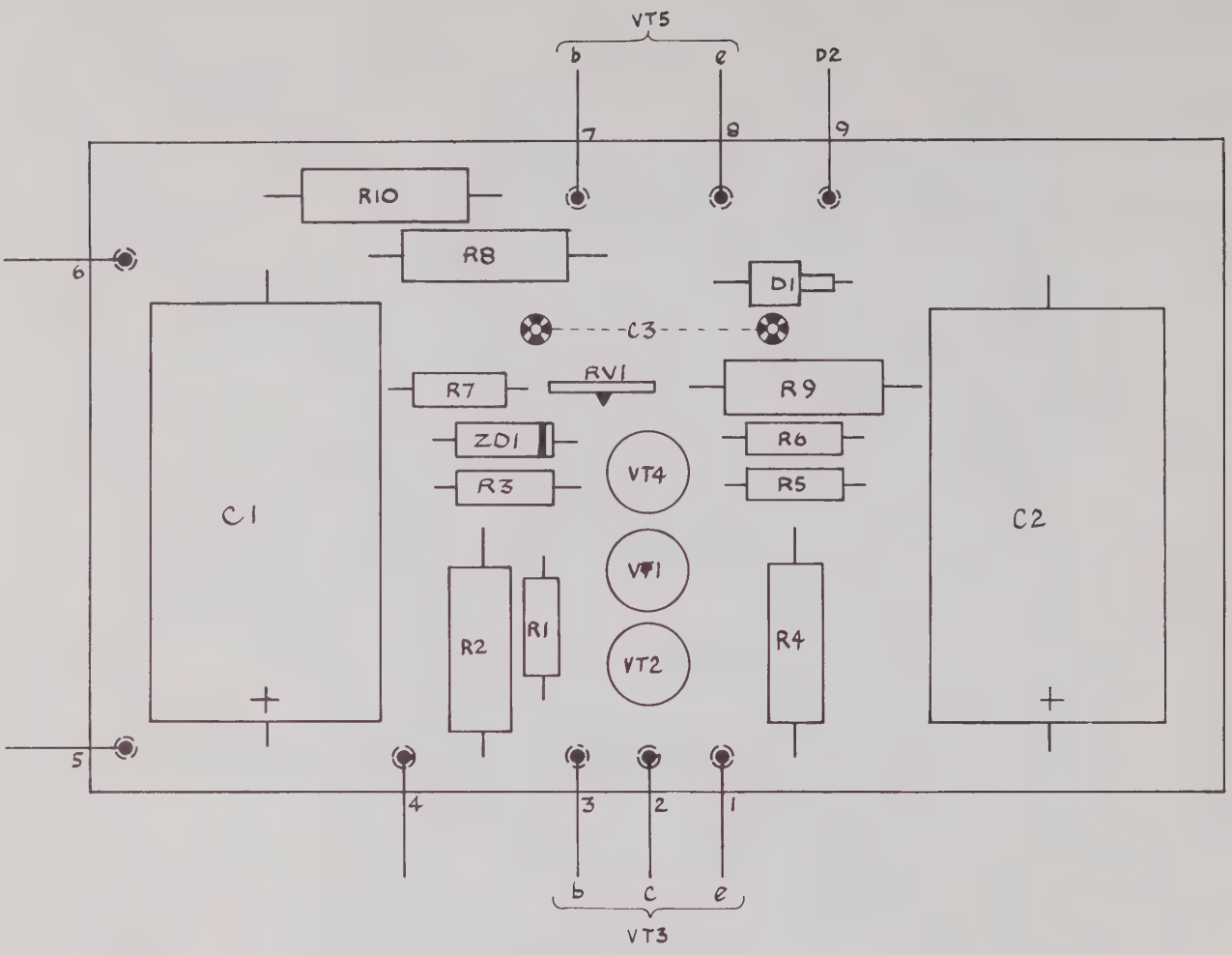


Fig. 6.29

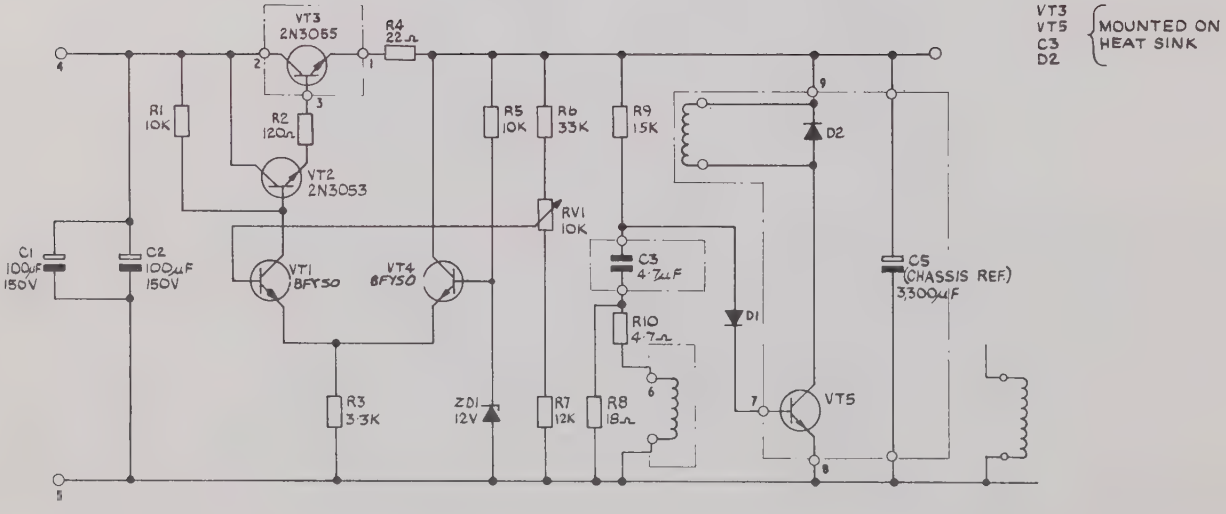
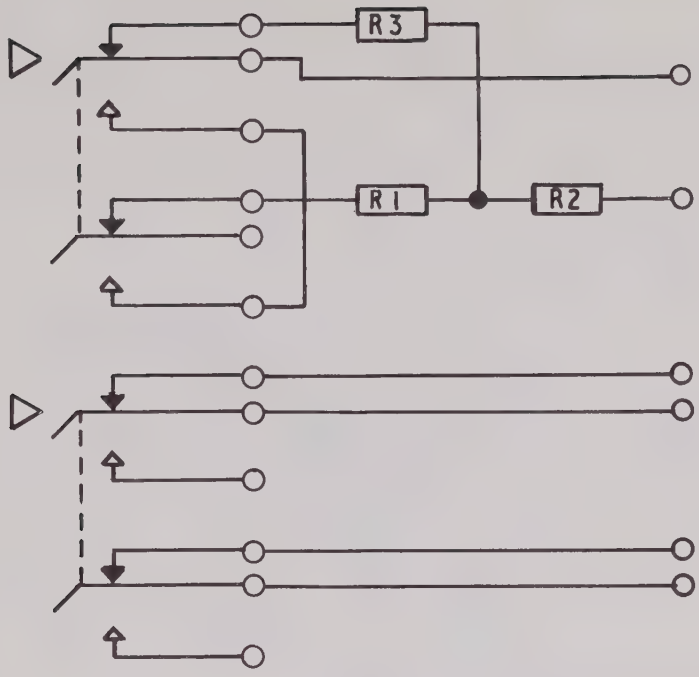


Fig. 6.30



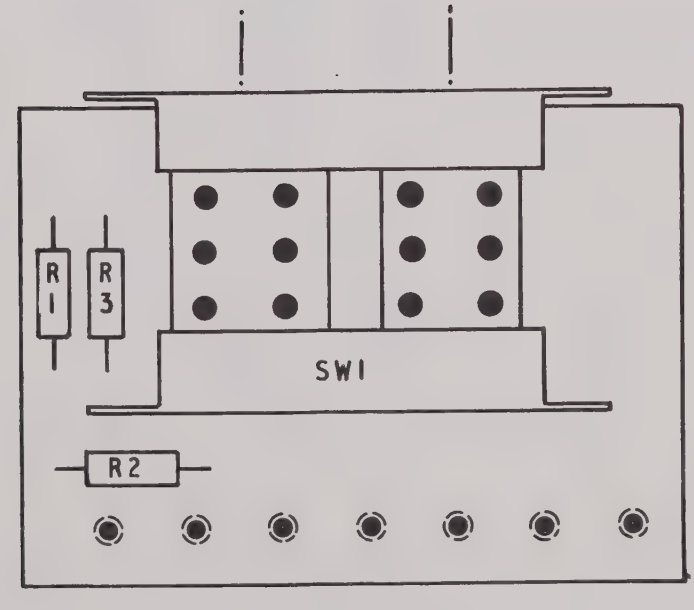


Fig. 6.31

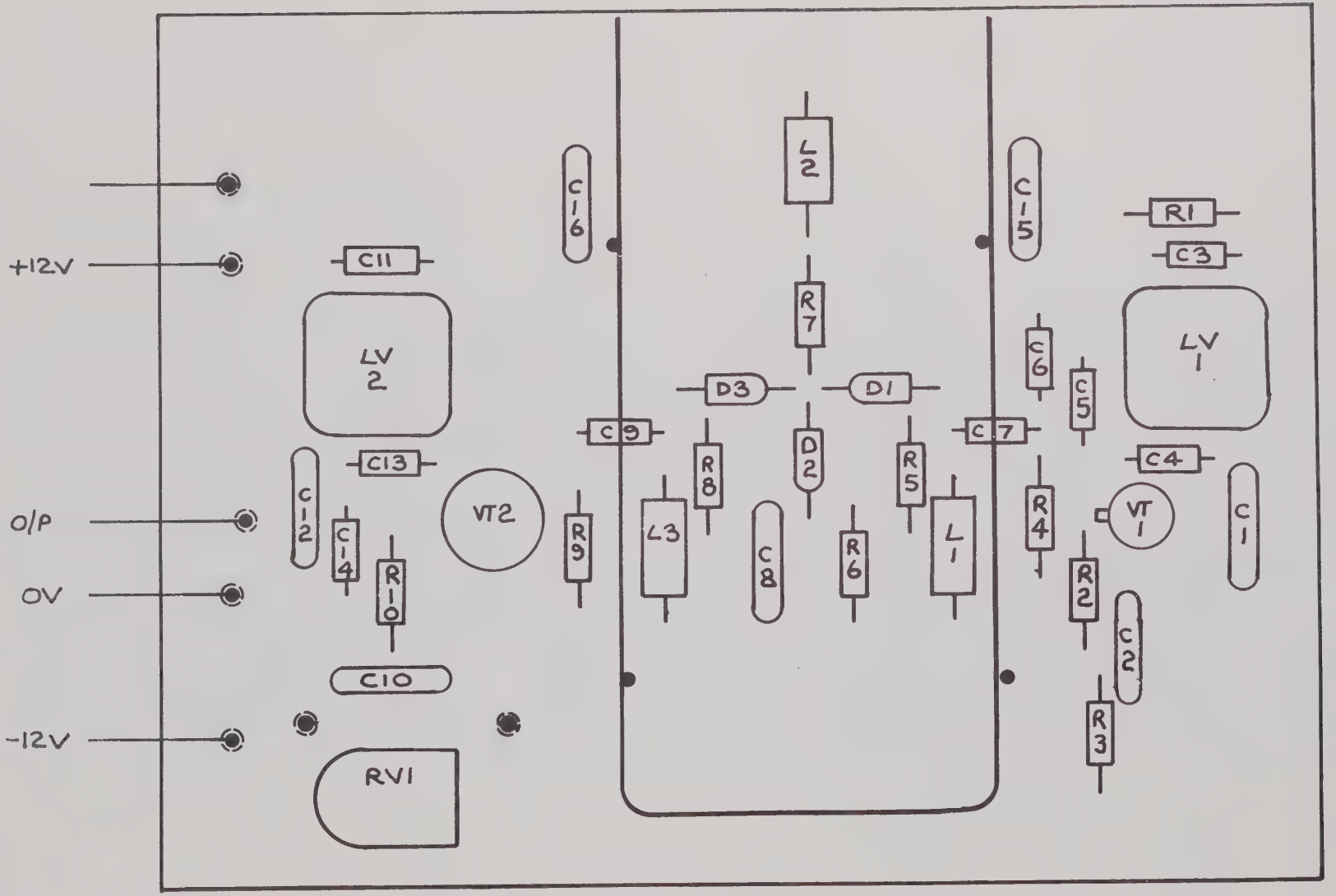
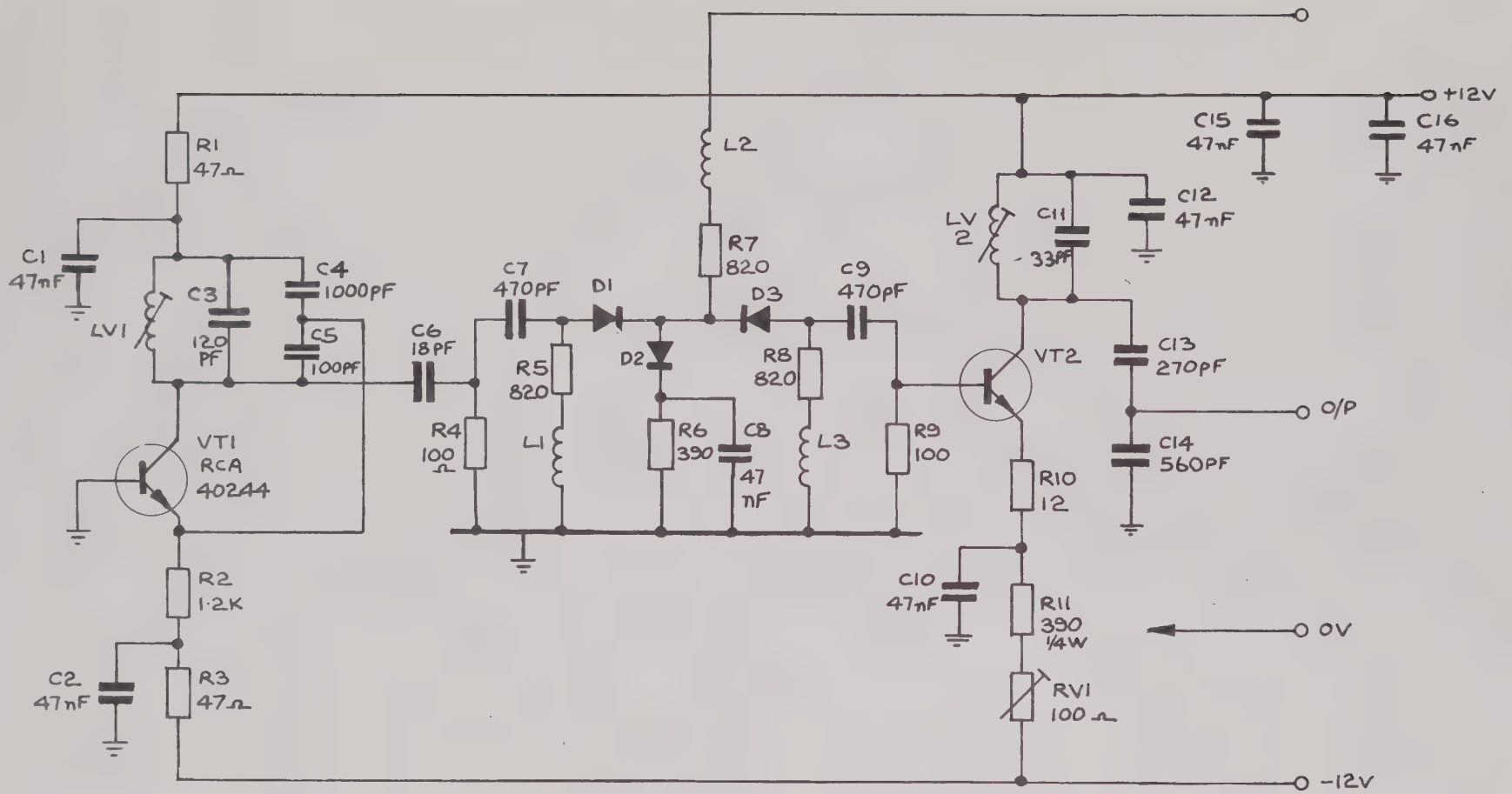

+12V
O/P
OV
-12V
C11
LV 2
C13
C12
C14
R10
C10
VT2
RV1
C16
R9
L3
C9
R8
C8
L2
R7
D3
D2
D1
R6
C7
R5
L1
C15
C6
C5
R4
R2
R3
C2
R1
C3
LV 1
C4
VT 1
C1

Fig. 6.32



DIODES TO BE BYX10

Fig. 6.33

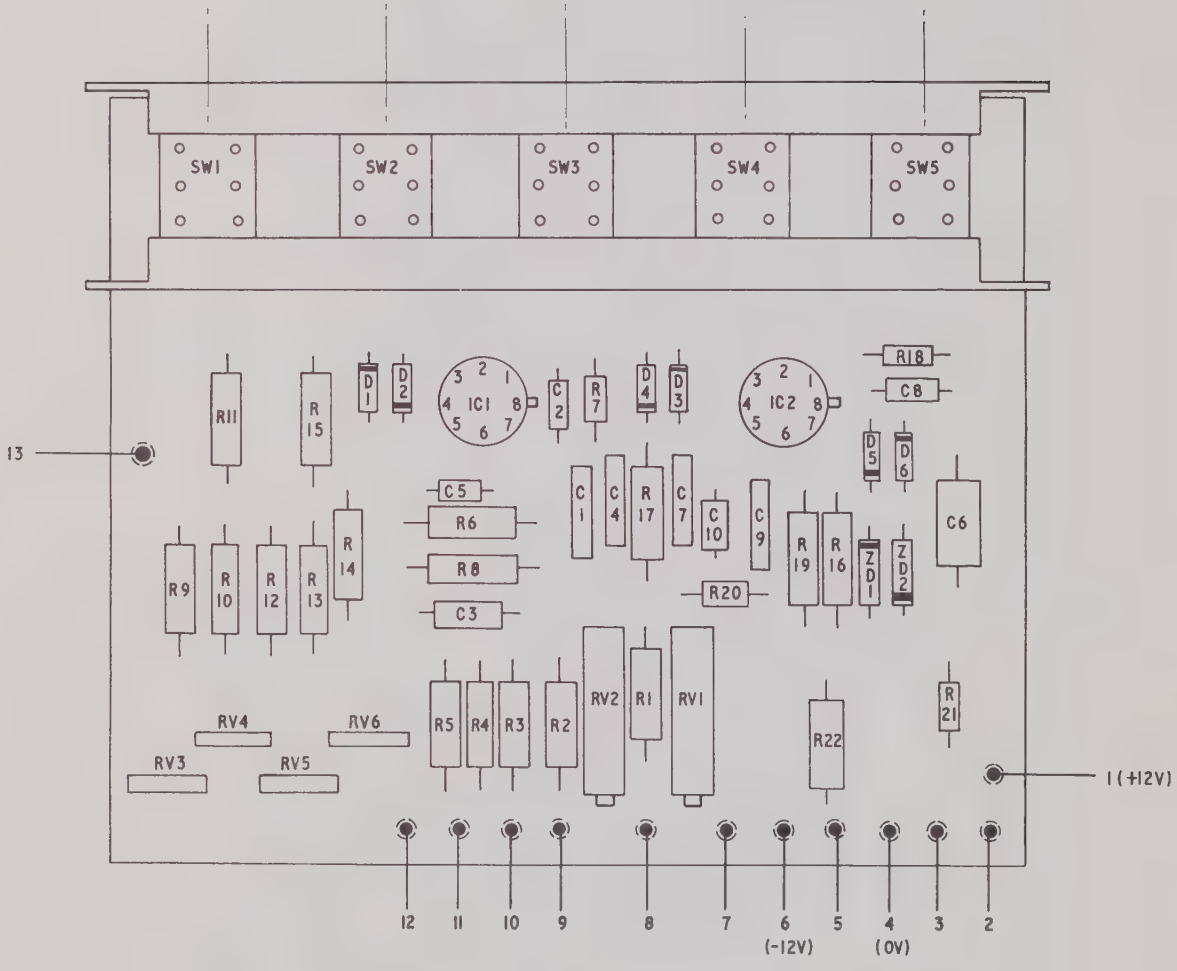

SW1
SW2
SW3
SW4
SW5
IC1
IC2
R11
R15
D1
D2
C2
R7
D4
D3
R18
C8
D5
D6
C5
R6
R8
C3
C1
C4
R17
C7
C10
C9
R19
R16
ZD1
ZD2
C6
R20
R9
R10
R12
R13
R14
RV4
RV6
RV3
RV5
R5
R4
R3
R2
RV2
R1
RV1
R22
R21
13
1 (+12V)
12
11
10
9
8
7
6
(-12V)
5
4
(0V)
3
2

Fig. 6.34

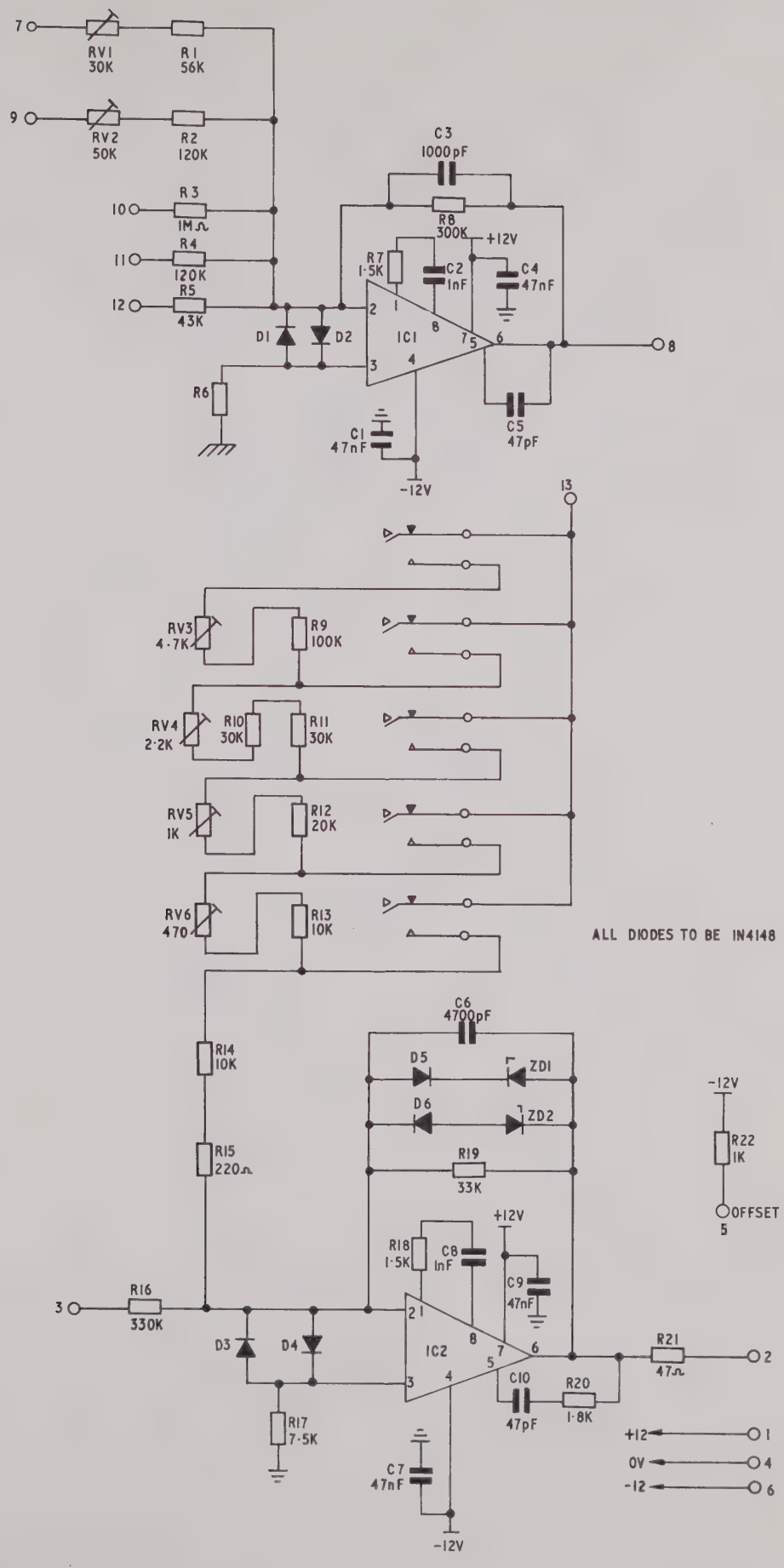

7
RV1
30K
R1
56K
9
RV2
50K
R2
120K
C3
1000pF
10
R3
1M
R8
300K
+12V
11
R4
120K
R7
1·5K
C2
1nF
C4
47nF
12
R5
43K
D1
D2
IC1
8
R6
C1
47nF
C5
47pF
-12V
13
RV3
4·7K
R9
100K
RV4
2·2K
R10
30K
R11
30K
RV5
1K
R12
20K
RV6
470
R13
10K
ALL DIODES TO BE IN4148
C6
4700pF
R14
10K
D5
ZD1
D6
ZD2
R15
220
R19
33K
-12V
R22
1K
OFFSET
5
+12V
R18
1·5K
C8
1nF
C9
47nF
3
R16
330K
D3
D4
IC2
R21
47
2
C10
47pF
R20
1·8K
R17
7·5K
C7
47nF
-12V
+12
1
0V
4
-12
6

Fig. 6.35

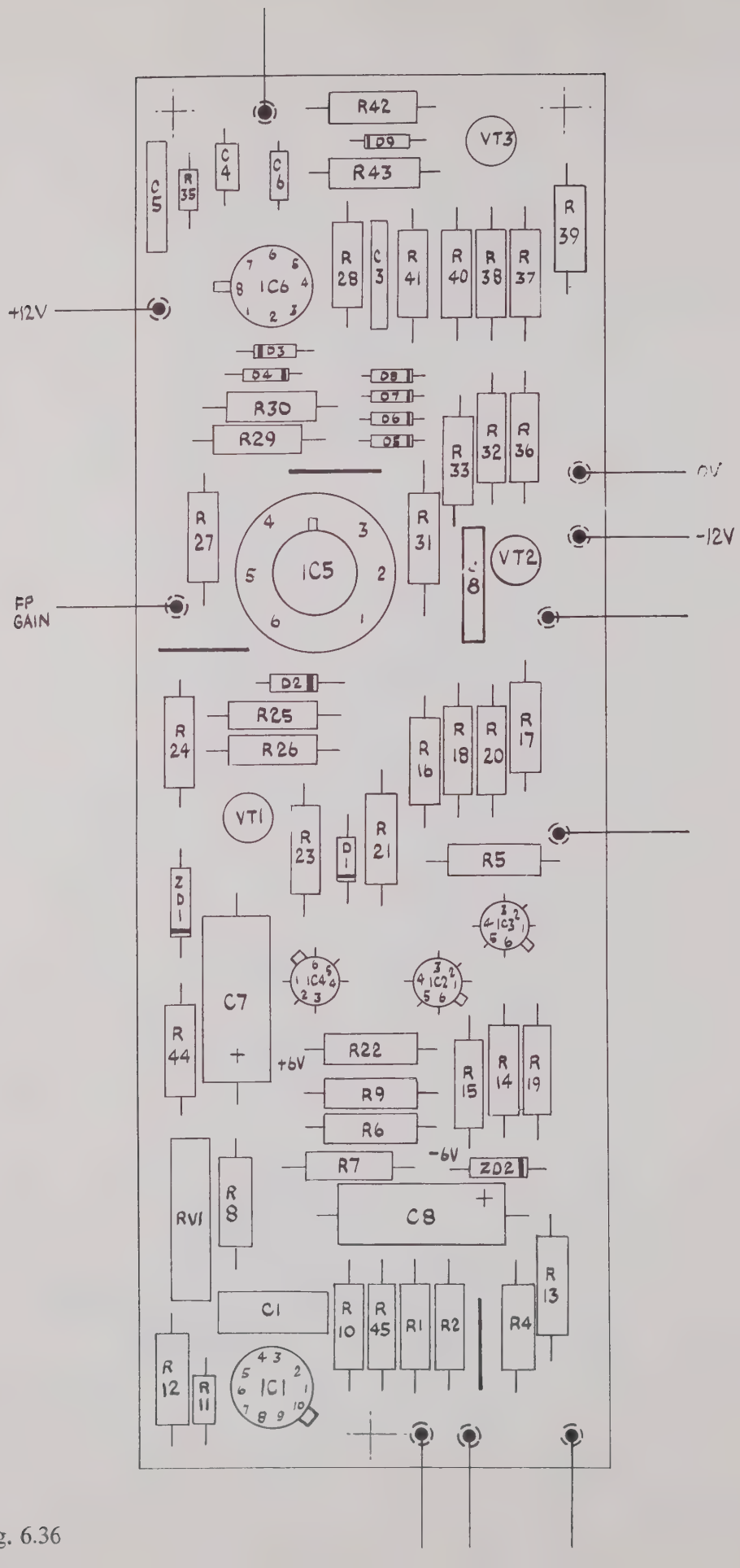

R42
D9
VT3
R43
C5
R35
C4
C6
R39
R28
C3
R41
R40
R38
R37
IC6
+12V
D3
D4
D8
D7
D6
D5
R30
R29
R33
R32
R36
0V
-12V
R27
IC5
R31
VT2
FP GAIN
D2
R25
R26
R24
R16
R18
R20
R17
VT1
R23
D1
R21
R5
ZD1
IC3
C7
IC4
IC2
R44
+6V
R22
R9
R6
R15
R14
R19
-6V
R7
ZD2
RV1
R8
C8
C1
R10
R45
R1
R2
R4
R13
R12
R11
IC1

Fig. 6.36

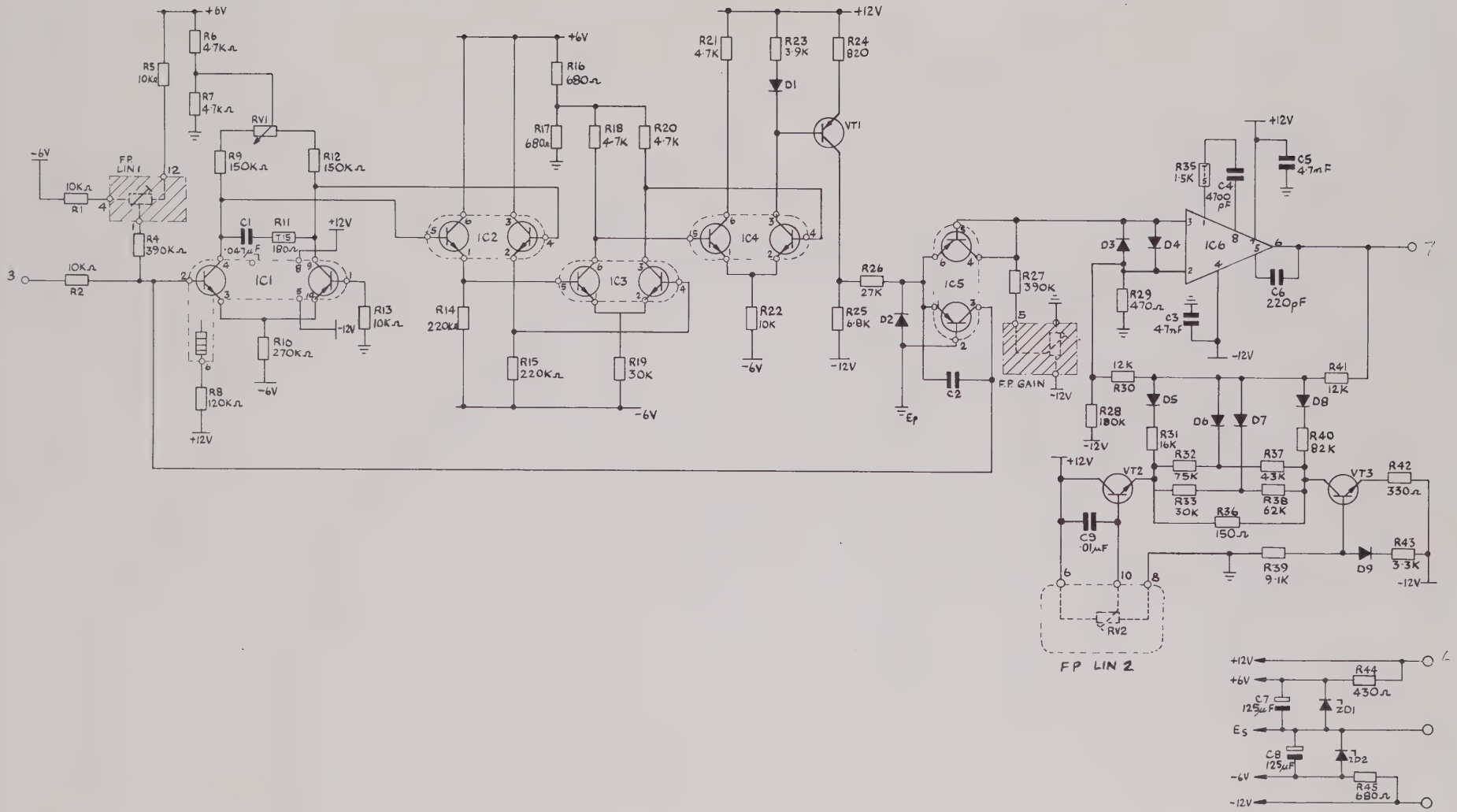

+6V
R6 4·7K
R5 10K
R7 4·7K
RV1
R9 150K
R12 150K
-6V
FP LIN 1
10K R1
R4 390K
3
10K R2
C1 ·047μF
R11 T15 180
+12V
IC1
R13 10K
R10 270K
-12V
-6V
R8 120K
+12V
IC2
R14 220K
R16 680
R17 680
R18 4·7K
R20 4·7K
R15 220K
R19 30K
-6V
IC3
IC4
R21 4·7K
R23 3·9K
D1
R24 820
VT1
+12V
R22 10K
-6V
R26 27K
R25 6·8K
-12V
D2
Ep
IC5
C2
R27 390K
F.P. GAIN
-12V
R35 1·5K
C4 4700 pF
C5 4·7nF
+12V
IC6
D3
D4
R29 470
C3 4·7nF
C6 220pF
-12V
7
12K R30
R41 12K
R28 180K
-12V
D5
D6
D7
D8
R31 16K
R40 82K
R32 75K
R37 4·3K
+12V
VT2
VT3
R42 330
R33 30K
R38 62K
R36 150
C9 ·01μF
R39 9·1K
D9
R43 3·3K
-12V
RV2
FP LIN 2
+12V
+6V
R44 430
C7 125μF
ZD1
Es
C8 125μF
ZD2
-6V
R45 680
-12V

Fig. 6.37

SECTION 7

PARTS LISTS

7.1 INTRODUCTION

7.2 The following Parts Lists contain relevant information concerning replaceable parts used in the Model 2100 Display Unit and its associated plug-in modules. Certain parts are listed 'A.O.T.' meaning 'adjust on test' and the selection of these components is made for the desired performance.

7.3 The following abbreviations are used in this Section:
uF = microfarad
uH = microhenry
R = ohms (eg, 10R = 10 ohms; 4R7 = 4.7 ohms)
K = kilohms (eg, 10K = 10000 ohms; 8K2 = 8200 ohms)

7.4 ORDERING INFORMATION

7.5 To order any part(s) from these lists, please specify the following information:
Instrument Model Number
Instrument Serial Number
Unit for which part is required (eg, PC Board No.)
Component Reference Number (eg, RV3, VT2, C21 etc)
Description (eg, 10K 5% 0.2W CARBON FILM RESISTOR)
Part Number.

UNIT	COMP	DESCRIPTION	PART NO
2100			
M/F	R1	39K 5% 0.2W CARBON FILM	025564
	R2	2R 5% 9W WIREWOUND	036278
	R3	2R 5% 9W WIREWOUND	036278
	R4	2R 5% 9W WIREWOUND	036278
	R5	82R 5% 0.2W CARBON FILM	020702
	RV1/S1	25K/SWITCH MOULDED CARBON	031735
	RV2/3	25K/5K MOULDED CARBON	031724
	RV4	5K MOULDED CARBON	031757
	RV5	5K MOULDED CARBON	031757
	RV6	5K MOULDED CARBON	031757
	RV7	10K MULTITURN CERMET	031779
	RV8	10K MULTITURN CERMET	031779
	RV9	10K MULTITURN CERMET	031779
	C1	10000uF 16V ELECTROLYTIC	031174
	C2	3300uF 100V ELECTROLYTIC	031185
	C3	10000uF 30V ELECTROLYTIC	031196
	C4	5000uF 25V ELECTROLYTIC	023936
	C5	5000uF 25V ELECTROLYTIC	023936
	L1,2	SCAN COILS	032538
	T1	MAINS TRANSFORMER	032604
	F1	FAN	035178
		FAN GUARD	035189
		FAN LEAD	035200
		AIR FILTER	032472
		CATHODE RAY TUBE M28-13GR	031361
	S2	3-BANK I/L SWITCH ASSY	032725
	S3	1-BANK L SWITCH ASSY	032714
	SK1-10	BNC SOCKET (QTY 10)	039353
	SK11	HYPERTAC SOCKET	031614
	FSH1	FUSEHOLDER	024959
	MS1,2	MAINS SELECTOR (QTY2)	032010
		PUSHBUTTON 12mm ROUND BLACK	032670
	LP1	LAMP (BELLING L1901 RED)	037939
HEAT SINKS			
HSA1	VT1	TRANSISTOR MJ490	035838
HSA2	VT1	TRANSISTOR 2N3055	031405
HSA3	VT1	TRANSISTOR 2N3055	031405
HSA4		NOT USED	
HSA5	VT1	TRANSISTOR 2N3055	031405
	VT2	TRANSISTOR 2N3055	031405
HSB1	D1	DIODE 1N3209	031328
	VT1	TRANSISTOR 2N3055	031405
HSC1	D1	DIODE 40110	037466
	VT1	TRANSISTOR 40440	037752
EHT		EHT CAPSULE TYPE 2	

UNIT	COMP	DESCRIPTION	PART NO
PC107	R1	3K3 0.5% 0.5W 50PPM METAL FILM	033825
	R2	3K3 0.5% 0.5W 50PPM METAL FILM	033825
	R3	2K2 5% 0.2W CARBON FILM	021175
	R4	1K5 0.5% 0.5W 50PPM METAL FILM	033737
	R5	220R 5% 0.2W CARBON FILM	020845
	R6	2K2 5% 0.2W CARBON FILM	021175
	R7	2K2 5% 0.2W CARBON FILM	021175
	R8	220R 5% 0.2W CARBON FILM	020845
	R9	1K 0.5% 0.5W 50PPM METAL FILM	033693
	R10	470R 0.5% 0.5W 50PPM METAL FILM	037785
	R11	4K7 0.5% 0.5W 50PPM METAL FILM	033869
	R12	1K 0.5% 0.5W 50PPM METAL FILM	033693
	R13	470R 0.5% 0.5W 50PPM METAL FILM	037785
	R14	4K7 0.5% 0.5W 50PPM METAL FILM	033869
	R15	1K 0.5% 0.5W 50PPM METAL FILM	033693
	R16	470R 0.5% 0.5W 50PPM METAL FILM	037785
	R17	4K7 0.5% 0.5W 50PPM METAL FILM	033869
	R18	4K7 5% 0.2W CARBON FILM	021307
	R19	27K 5% 0.2W CARBON FILM	021637
	R20	470R 5% 0.2W CARBON FILM	020933
	R21	4K7 5% 0.2W CARBON FILM	021307
	R22	27K 5% 0.2W CARBON FILM	021637
	R23	470R 5% 0.2W CARBON FILM	020933
	R24	4K7 5% 0.2W CARBON FILM	021307
	R25	27K 5% 0.2W CARBON FILM	021637
	R26	470R 5% 0.2W CARBON FILM	020933
	R27	180K 5% 0.2W CARBON FILM	021890
	R28	10K 5% 0.2W CARBON FILM	021439
	R29	10K 5% 0.2W CARBON FILM	021439
	R30	10K 5% 0.2W CARBON FILM	021439
	R31	470R 0.5% 0.5W 50PPM METAL FILM	037785
	R32	470R 0.5% 0.5W 50PPM METAL FILM	037785
	R33	470R 0.5% 0.5W 50PPM METAL FILM	037785
	R34	33K 5% 0.2W CARBON FILM	021692
	R35	33K 5% 0.2W CARBON FILM	021692
	R36	33K 5% 0.2W CARBON FILM	021692
	R37	10M 5% 0.2W CARBON FILM	022330
	R38	1K 5% 0.2W CARBON FILM	021076
	R39	390R 5% 0.2W CARBON FILM	030525
	R40	390R 5% 0.2W CARBON FILM	030525
	R41	390R 5% 0.2W CARBON FILM	030525
	R42	390R 5% 0.2W CARBON FILM	030525
	R43	390R 5% 0.2W CARBON FILM	030525
	R44	390R 5% 0.2W CARBON FILM	030525
	R45	2K2 5% 0.2W CARBON FILM	021175
	R46	2K2 5% 0.2W CARBON FILM	021175
	R47	1K 5% 0.2W CARBON FILM	021076
	R48	2K2 5% 0.2W CARBON FILM	021175
	R49	10K 5% 0.2W CARBON FILM	021439
	R50	10K 5% 0.2W CARBON FILM	021439
	R51	10K 5% 0.2W CARBON FILM	021439
	R52	10K 5% 0.2W CARBON FILM	021439
	R53	10K 5% 0.2W CARBON FILM	021439
	R54	10K 5% 0.2W CARBON FILM	021439
	R55	1K5 5% 0.2W CARBON FILM	021131
	R56	1K 5% 0.2W CARBON FILM	021076
	R57	1K 5% 0.2W CARBON FILM	021076
	R58	1K 5% 0.2W CARBON FILM	021076
	R59	1K5 5% 0.2W CARBON FILM	021131
	R60	100R 10% 1.0W CARBON	037499
	R61	39R 5% 0.2W CARBON FILM	030503
	R62	13K 0.5% 0.5W 50PPM METAL FILM	033979
	R63	18K 0.5% 0.5W 50PPM METAL FILM	034023
	R64	39K 0.5% 0.5W 50PPM METAL FILM	034111
	R65	39K 0.5% 0.5W 50PPM METAL FILM	034111
	R66	27K 0.5% 0.5W 50PPM METAL FILM	034067
	R67	1M 5% 0.2W CARBON FILM	022055
	R68	1K5 5% 0.2W CARBON FILM	021131
	R69	27K 0.5% 0.5W 50PPM METAL FILM	034067
	R70	2K2 0.5% 0.5W 50PPM METAL FILM	033781
	R71	470R 5% 0.2W CARBON FILM	020933
	R72	15K 5% 0.2W CARBON FILM	021494
	R73	15K 0.5% 0.5W 50PPM METAL FILM	034001
	R74	2K2 5% 0.5W CARBON	037477
	R75	10R 5% 3.0W WIREWOUND	037510
	R76	39R 5% 3.0W WIREWOUND	037521

UNIT	COMP	DESCRIPTION	PART NO
PC107	RV1	10K 0.2W CARBON PRESET LINEAR	025542
	RV2	470R 0.2W CARBON PRESET LINEAR	023364
	RV3	470R 0.2W CARBON PRESET LINEAR	023364
	RV4	470R 0.2W CARBON PRESET LINEAR	023364
	RV5	10K 0.2W CARBON PRESET LINEAR	025542
	RV6	10K 0.2W CARBON PRESET LINEAR	025542
	RV7	10K 0.2W CARBON PRESET LINEAR	025542
	C1	1uF 100V POLYCARBONATE	024024
	C2	1uF 100V POLYCARBONATE	024024
	C3	20uF 16V ELECTROLYTIC	023716
	C4	20uF 16V ELECTROLYTIC	023716
	C5	1uF 100V POLYCARBONATE	024024
	C6	22nF 100V POLYCARBONATE	023958
	C7	2nF 5% 63V POLYSTYRENE	024211
	C8	4.7nF 5% 63V POLYSTYRENE	034738
	C9	4.7nF 5% 63V POLYSTYRENE	034738
	C10	100pF 5% 63V POLYSTYRENE	034881
	C11	0.22uF 100V POLYCARBONATE	024002
	C12	22nF 100V POLYCARBONATE	023958
	C13	22nF 100V POLYCARBONATE	023958
	C14	22nF 100V POLYCARBONATE	023958
	C15	22nF 100V POLYCARBONATE	023958
	C16	22nF 100V POLYCARBONATE	023958
	C17	22nF 100V POLYCARBONATE	023958
	C18	10pF 5% 63V POLYSTYRENE	034793
	C19	47nF 30V CERAMIC	024332
	C20	47nF 30V CERAMIC	024332
	C21	4.7pF 5% 63V POLYSTYRENE	035651
	C22	47nF 30V CERAMIC	024332
	C23	47nF 30V CERAMIC	024332
	C24	47nF 30V CERAMIC	024332
	C25	47nF 30V CERAMIC	024332
	C26	47nF 30V CERAMIC	024332
	C27	47nF 30V CERAMIC	024332
	C28	47nF 30V CERAMIC	024332
	C29	47nF 30V CERAMIC	024332
	C30	47nF 30V CERAMIC	024332
	C31	220pF 5% 63V POLYSTYRENE	033275
	C32	47nF 30V CERAMIC	024332
	C33	47nF 30V CERAMIC	024332
	C34	47nF 30V CERAMIC	024332
	C35	220pF 5% 63V POLYSTYRENE	033275
	C36	100pF 5% 63V POLYSTYRENE	034881
	C37	2nF 5% 63V POLYSTYRENE	024211
	C38	220pF 5% 63V POLYSTYRENE	033275
	C39	220pF 5% 63V POLYSTYRENE	033275
	C40	220pF 5% 63V POLYSTYRENE	033275
	C41	220pF 5% 63V POLYSTYRENE	033275
	C42	220pF 5% 63V POLYSTYRENE	033275
	C43	220pF 5% 63V POLYSTYRENE	033275
	C44	0.22uF 100V POLYCARBONATE	024002
	C45	400uF 25V ELECTROLYTIC	023892
	C46	1uF 100V POLYCARBONATE	024024
	C47	1nF 5% 63V POLYSTYRENE	024200
	C48	100pF 5% 63V POLYSTYRENE	034881
	C49	47nF 30V CERAMIC	024332
	C50	47pF 5% 63V POLYSTYRENE	034837
	C51	22uF 35V ELECTROLYTIC	031229
	C52	47nF 30V CERAMIC	024332
	C53	22uF 35V ELECTROLYTIC	031229
	C54	50uF 6.4V ELECTROLYTIC	023793
	L1	10uH	032428
	L2	10uH	032428
	L3	10uH	032428
	D1	DIODE 1N4148	024365
		to	
	D44	DIODE 1N4148	024365
	D45	DIODE 10C1	024420
	D46	DIODE 10C1	024420
	D47	DIODE 1N4148	024365
	D48	DIODE 1N4148	024365
	ZD1	ZENER DIODE 11V 5% 400mW	024618
	ZD2	ZENER DIODE 3.6V 5% 1W	035343

UNIT	COMP	DESCRIPTION	PART NO
PC107	VT1	TRANSISTOR BFY50	024816
	VT2	TRANSISTOR BC172	024772
	VT3	TRANSISTOR BC172	024772
	VT4	TRANSISTOR 2N2369A	030723
	VT5	TRANSISTOR 2N2369A	030723
	VT6	TRANSISTOR 2N2369A	030723
	VT7	TRANSISTOR BFY50	024816
	VT8	TRANSISTOR BFY50	024816
	VT9	TRANSISTOR BFY50	024816
	VT10	TRANSISTOR BFX30	024739
	VT11	TRANSISTOR BFY50	024816
	IC1	INTEGRATED CIRCUIT MC889P	037587
	IC2	INTEGRATED CIRCUIT SL701C	037224
	IC3	INTEGRATED CIRCUIT SL701C	037224
	IC4	INTEGRATED CIRCUIT SL701C	037224
	IC5	INTEGRATED CIRCUIT SL701C	037224
	IC6	INTEGRATED CIRCUIT SL701C	037224
	IC7	INTEGRATED CIRCUIT SL701C	037224
	IC8	INTEGRATED CIRCUIT 709T	031471
	IC9	INTEGRATED CIRCUIT MC889P	037587
	IC10	INTEGRATED CIRCUIT MC889P	037587
	IC11	INTEGRATED CIRCUIT MC824P	037576
	IC12	INTEGRATED CIRCUIT MC890P	037598
	IC13	INTEGRATED CIRCUIT 709T	031471
		14-PIN D.I.L. HOLDER (QTY 5)	025014
		TO5 HEAT SINK (QTY 2)	032461
		PC MESL 107	038093
PC108	R1	15K 10% 0.5W CARBON	036102
	C1	0.47uF 400V POLYESTER	035442
	C2	32uF 150V ELECTROLYTIC	035508
	D1,2	DUAL DIODE 10DC1R	024453
	D3,4	DUAL DIODE 10DC1	024442
	D5,6	DUAL DIODE 10DC1R	024453
	D7,8	DUAL DIODE 10DC1	024442
	D9	DIODE BYX10	024387
	D10	DIODE BYX10	024387
	D11	DIODE BYX10	024387
	ZD1	ZENER DIODE 180V 5% 1W	036971
	ZD2	ZENER DIODE 180V 5% 1W	036971
		PC MESL 108	032263
PC110	R1	1K5 5% 0.2W CARBON FILM	021131
	R2	10K 5% 0.2W CARBON FILM	021439
	R3	470R 10% 1.0W CARBON	037488
	R4	1K 5% 0.2W CARBON FILM	021076
	R5	15K 5% 0.2W CARBON FILM	021494
	R6	100K 5% 0.2W CARBON FILM	021824
	R7	2M2 5% 0.2W CARBON FILM	022154
	RV1	100K 0.2W CARBON PRESET LINEAR	036124
	RV2	2M2 PRESET - SLIDER TYPE	031867
	C1	1nF 5% 63V POLYSTYRENE	024200
	C2	1nF CERAMIC	024299
	C3	1uF 100V POLYCARBONATE	024024
	C4	1nF CERAMIC	024299
	C5	0.22uF 100V POLYCARBONATE	024002
	C6	5uF 100V ELECTROLYTIC	037565
	D1	DIODE BYX10	024387
	D2	DIODE BYX10	024387

UNIT	COMP	DESCRIPTION	PART NO
PC110	VT1	TRANSISTOR 2N5262	037609
	VT2	TRANSISTOR BFY41	035035
		VALVEHOLDER B8H	032021
		PC MESL 110	038104
PC179	R1	2R7 5% 6W WIREWOUND	037422
	R2	2R7 5% 6W WIREWOUND	037422
	R3	A.O.T. OR WIRE LINK	
	R4	A.O.T. OR WIRE LINK	
	C1	1.0uF 100V POLYCARBONATE	024024
	C2	1.0uF 100V POLYCARBONATE	024024
	C3	1.0uF 100V POLYCARBONATE	024024
	C4	1.0uF 100V POLYCARBONATE	024024
	C5	0.01uF 100V POLYCARBONATE	023947
	C6	0.01uF 100V POLYCARBONATE	023947
	IC1	VOLTAGE REGULATOR 809	037906
	IC2	VOLTAGE REGULATOR 859	037917
		PC MESL 179	038159
PC180	R1	2R7 5% 6W WIREWOUND	037422
	R2	A.O.T. OR WIRE LINK	
	R3	1K5 5% 0.2W CARBON FILM	021131
	R4	150R 5% 0.2W CARBON FILM	020779
	R5	330R 5% 0.2W CARBON FILM	020889
	R6	68R 5% 0.2W CARBON FILM	020680
	R7	3R9 5% 6W WIREWOUND	036410
	C1	1uF 100V POLYCARBONATE	024024
	C2	0.01uF 100V POLYCARBONATE	023947
	C3	1uF 100V POLYCARBONATE	024024
	C4	0.01uF 5% 63V POLYSTYRENE	034760
	C5	80uF 25V ELECTROLYTIC	031273
	C6	0.022uF 400V POLYCARBONATE	023950
	C7	0.022uF 400V POLYCARBONATE	023950
	C8	0.022uF 400V POLYCARBONATE	023950
	C9	0.022uF 400V POLYCARBONATE	023950
	C10	0.022uF 400V POLYCARBONATE	023950
	C11	0.022uF 400V POLYCARBONATE	023950
	D1	DIODE BYX10	024387
	VT1	TRANSISTOR 2N2222	037631
	VT2	TRANSISTOR BFX85	036267
	IC1	VOLTAGE REGULATOR 809	037906
	T1	LINE TRANSFORMER	
		FERROX CORES FX1238 (QTY 2)	032439
		CLAMP	032362
		PC MESL 180	038170
PC198	R1	120R 5% 0.2W CARBON FILM	020757
	R2	5K6 10% 0.5W CARBON	036036
	R3	56K 5% 0.2W CARBON FILM	021758
	R4	1K 5% 0.2W CARBON FILM	021076
	R5	10K 10% 0.5W CARBON	036047
	R6	100R 5% 0.2W CARBON FILM	020724
	R7	39R 10% 3W WIREWOUND	037521
	R8	1K5 10% 6W WIREWOUND	037554
	R9	100K 0.5% 0.5W 50PPM METAL FILM	034221
	R10	1K8 0.5% 0.5W 50PPM METAL FILM	033759

UNIT	COMP	DESCRIPTION	PART NO
PC198	R11	18R 10% 6W WIREWOUND	037543
	R12	1K5 10% 6W WIREWOUND	037554
	R13	4R7 10% 6W WIREWOUND	037532
	C1	100uF 160V ELECTROLYTIC	036091
	C2	100uF 160V ELECTROLYTIC	036091
	C3	4.7uF 100V POLYCARBONATE	025344
	C4	0.47uF 100V POLYCARBONATE	024013
	D1,2	DUAL DIODE 10DC1	024442
	D3,4	DUAL DIODE 10DC1R	024453
	D5	DIODE 10D1	024431
	D6	DIODE 10D1	024431
	D7	DIODE 10D1	024431
	ZD1	ZENER DIODE 18V 5% 1W	037818
	ZD2	ZENER DIODE 15V 5% 1W	037807
	ZD3	ZENER DIODE 39V 5% 1W	035915
	VT1	TRANSISTOR 2N3053	024783
	VT2	TRANSISTOR 2N5400	037620
	VT3	TRANSISTOR 2N5400	037620
		PC MESL 198	038181

NOTE:
THE FOLLOWING PARTS APPLY TO THE MODELS 2101 AND 2104 PLUG-IN MODULES. THE FRONT-PANEL COMPONENTS ARE REQUIRED IN QUANTITY 1 FOR THE 2101 MODULE AND QUANTITY 2 FOR THE 2104 MODULE, WITH THE EXCEPTION OF R1 WHERE QUANTITY 2 IS REQUIRED FOR MODEL 2101 AND QUANTITY 1 FOR MODEL 2104, AND PL1 WHERE QUANTITY 1 IS REQUIRED FOR EITHER MODEL.
MODEL 2101 IS FITTED WITH QUANTITY 1 PC BOARDS 115 AND 172.
MODEL 2104 IS FITTED WITH QUANTITY 2 PC BOARDS 115 AND 172 AND, IN ADDITION, IS FITTED WITH PC BOARD 116.

UNIT	COMP	DESCRIPTION	PART NO
FRONT PANEL	R1	1K 5% 0.2W CARBON FILM	021076
	RV1	10K MULTITURN CERMET	031779
	RV2	10K MULTITURN CERMET	031779
	RV3	10K MULTITURN CERMET	031779
	RV4	5K 10-TURN WIREWOUND	031834
		10-TURN DIGITAL DIAL	031801
	SK1	BNC SOCKET	034353
	PL1	HYPERTAC PLUG	031625
		'CAMLOC'	032417
PC115	R1	56K 0.5% 0.5W 50PPM METAL FILM	034155
	R2	120K 0.5% 0.5W 50PPM METAL FILM	034232
	R3	1M 0.5% 0.5W 50PPM METAL FILM	037774
	R4	120K 0.5% 0.5W 50PPM METAL FILM	034232
	R5	43K 0.5% 0.5W 50PPM METAL FILM	034122
	R6	33K 0.5% 0.5W 50PPM METAL FILM	034089
	R7	1K5 5% 0.2W CARBON FILM	021131
	R8	68K 0.5% 0.5W 50PPM METAL FILM	034177
	R9	100K 0.5% 0.5W 50PPM METAL FILM	034221
	R10	30K 0.5% 0.5W 50PPM METAL FILM	034078
	R11	30K 0.5% 0.5W 50PPM METAL FILM	034078
	R12	20K 0.5% 0.5W 50PPM METAL FILM	034034
	R13	10K 0.5% 0.5W 50PPM METAL FILM	033957

UNIT	COMP	DESCRIPTION	PART NO
PC115	R14	10K 0.5% 0.5W 50PPM METAL FILM	033957
	R15	NOT USED	
	R16	330K 0.5% 0.5W 50PPM METAL FILM	034320
	R17	7K5 0.5% 0.5W 50PPM METAL FILM	033924
	R18	1K5 5% 0.2W CARBON FILM	020625
	R19	33K 0.5% 0.5W 50PPM METAL FILM	034089
	R20	1K8 5% 0.2W CARBON FILM	021153
	R21	47R 5% 0.2W CARBON FILM	020625
	R22	1K 0.5% 0.5W 50PPM METAL FILM	033693
	RV1	50K MULTITURN CERMET	031823
	RV2	50K MULTITURN CERMET	031823
	C1	47nF 30V CERAMIC	024332
	C2	1nF 5% 63V POLYSTYRENE	024200
	C3	220pF 5% 63V POLYSTYRENE	033275
	C4	47nF 30V CERAMIC	024332
	C5	47pF 5% 63V POLYSTYRENE	034837
	C6	470pF 5% 63V POLYSTYRENE	034716
	C7	47nF 30V CERAMIC	024332
	C8	1nF 5% 63V POLYSTYRENE	024200
	C9	47nF 30V CERAMIC	024332
	C10	47pF 5% 63V POLYSTYRENE	034837
	D1	DIODE 1N4148	024365
	D2	DIODE 1N4148	024365
	D3	DIODE 1N4148	024365
	D4	DIODE 1N4148	024365
	D5	DIODE 1N4148	024365
	D6	DIODE 1N4148	024365
	ZD1	ZENER DIODE 7.5V 5% 400mW	024574
	ZD2	ZENER DIODE 7.5V 5% 400mW	024574
	IC1	INTEGRATED CIRCUIT 709T	031471
	IC2	INTEGRATED CIRCUIT 709T	031471
		5-BANK I/L SWITCH ASSY	032736
		PC MESL 115	038115
PC172	R1	100K 1.0% 0.5W 5PPM METAL FILM	036146
	R2	10K 1.0% 0.5W 15PPM METAL FILM	036245
	R3	390K 1.0% 0.5W 15PPM METAL FILM	036630
	R4	100K 1.0% 0.5W 5PPM METAL FILM	036146
	R5	4K7 1.0% 0.5W 15PPM METAL FILM	036179
	R6	4K7 1.0% 0.5W 15PPM METAL FILM	036179
	R7	120K 0.5% 0.5W 50PPM METAL FILM	034232
	R8	100K 1.0% 0.5W 5PPM METAL FILM	036146
	R9	270K 1.0% 0.5W 15PPM METAL FILM	036212
	R10	18K 5% 0.2W CARBON FILM	021538
	R11	100K 1.0% 0.5W 5PPM METAL FILM	036146
	R12	10K 1.0% 0.5W 15PPM METAL FILM	036245
	R13	39K 0.5% 0.5W 50PPM METAL FILM	034111
	R14	27K 0.5% 0.5W 50PPM METAL FILM	034067
	R15	360K 1.0% 0.5W 15PPM METAL FILM	036201
	R16	150K 1.0% 0.5W 15PPM METAL FILM	036157
	R17	1K5 0.5% 0.5W 50PPM METAL FILM	033737
	R18	12K 0.5% 0.5W 50PPM METAL FILM	033968
	R19	16K 0.5% 0.5W 50PPM METAL FILM	034012
	R20	75K 0.5% 0.5W 50PPM METAL FILM	034188
	R21	30K 0.5% 0.5W 50PPM METAL FILM	034078
	R22	1K5 5% 0.2W CARBON FILM	021131
	R23	150R 1% 0.5% 100PPM METAL OXIDE	027126
	R24	43K 0.5% 0.5W 50PPM METAL FILM	034122
	R25	62K 0.5% 0.5W 50PPM METAL FILM	034166
	R26	8K2 0.5% 0.5W 50PPM METAL FILM	033935
	R27	100K 0.5% 0.5W 50PPM METAL FILM	034221
	R28	12K 0.5% 0.5W 50PPM METAL FILM	033968
	R29	330R 0.5% 0.5W 50PPM METAL FILM	036619
	R30	3K3 0.5% 0.5W 50PPM METAL FILM	033825
	R31	100R 0.5% 0.5W 50PPM METAL FILM	033168
	R32	430R 0.5% 0.5W 50PPM METAL FILM	036234
PC172	R33	680R 0.5% 0.5W 50PPM METAL FILM	036223
	R34	100R 0.5% 0.5W 50PPM METAL FILM	033168
	RV1	10K MULTITURN CERMET	031812
	C1	1uF 100V POLYCARBONATE	024024
	C2	10nF CERAMIC	036399
	C3	47nF 30V CERAMIC	024332
	C4	4.7nF 5% 63V POLYSTYRENE	034738
	C5	47nF 30V CERAMIC	024332
	C6	220pF 5% 63V POLYSTYRENE	033275
	C7	125uF 10V ELECTROLYTIC	023837
	C8	125uF 10V ELECTROLYTIC	023837
	D1	DIODE 1N4148	024365
		to	
	D8	DIODE 1N4148	024365
	ZD1	ZENER DIODE 10V 5% 400mW	024607
	ZD2	ZENER DIODE 10V 5% 400mW	024607
	ZD3	REFERENCE ZENER DIODE 1N827	036355
	ZD4	REFERENCE ZENER DIODE 1N827	036355
	VT1	TRANSISTOR BC172	024772
	VT2	TRANSISTOR BC172	024772
	IC1	INTEGRATED CIRCUIT 726	034573
	IC2	INTEGRATED CIRCUIT 118A	035706
	IC3	INTEGRATED CIRCUIT 2N3349	031438
	IC4	INTEGRATED CIRCUIT 709T	031471
		TRANSISTOR OVEN TO5 115°C	032450
		PC MESL 172	038148
PC116	RV1	50K MULTITURN CERMET	031823
	RV2	50K MULTITURN CERMET	031823
		3-BANK I/L SWITCH ASSY	032725
		PC MESL 116	038126

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